JOURNAL of the
SOCIETY of MOTION PICTURE and TELEVISION ENGINEERS

In This Issue

APRIL 1950

Standards

Forty-nine American Standards on Motion Pictures have been published in seven different issues of the *Journal* since March, 1946. Six more appear in this issue beginning on page 494, to bring the total to fifty-five. New members will be pleased to learn that all are available from the Society in a sturdy loose-leaf binder at a price of $10.50. Included also is a reprint of the ten-page "Recommendations for 16- and 8-Mm Sprocket Design," published in the February, 1950, *Journal*. Within the last few days, all members who have these binders were notified that the new standards have been completed. All who order the binder and set of standards now will be notified in the future as additional standards are completed. Orders should be placed directly with the Society, and $0.21 to cover city sales tax should be included with any orders from New York City.

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Society of Motion Picture and Television Engineers

342 Madison Avenue, New York 17, N.Y., Tel. Mu 2-2185
Boyce Nemec, Executive Secretary

The Eidophor Method For Theater Television

By E. Labin

Federal Telecommunication Laboratories, Inc., Nutley, N.J.

Summary—The paper considers briefly some system aspects of theater television. The most important single technical problem of theater television remains the method used for large-screen projection. A new system, developed in Switzerland, using a special electromechanical accumulation process is described briefly. It gives projection on full-size screens with ordinary lighting. The system is still in the stage of early development, but has already proven quite promising.

Conceptions of how theater television will be used are not yet clearly settled. This is partially due to the limitations of the available technical tools, and partially to the difficulties of understanding how theater television will fit in with the normal movie programs.

Figure 1 represents a possible network for theater television. It is set up of urban, or local, networks, interconnected through long distance communication links. In each local network there would be one or more centers. The pictures originating at special studios in the city (stadiums, theaters, nightclubs, or perhaps as received from broadcast studios) are received in the local center after transmission through local telephone facilities, or, more likely, through short range microwave links. In this television distribution center, the pictures may be recorded on films, or may be rerouted immediately to the various theaters in the city and may also be sent through long distance networks to another city. In other words, the center operates like a telephone central office, receiving the messages from various points and retransmitting them to the customers. In a city where numerous theaters are grouped company-wise, it may be imagined that each company would have one central office of this type. In other cities, one central office may operate as a sort of limited common carrier for various theater owners. The long distance intercity links may, in turn, be operated directly by theater owners or may be facilities rented from a common carrier company.

The technical tools for setting up a network of the type described

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in Fig. 1 can be grouped in three main categories: transmission, pickup or camera, and projector. The transmission problems can be solved with known methods and it is now possible to equip, with microwave links or coaxial cables, both the local and the long distance networks. While continuous progress is still to be expected in the design of improved cameras, it is well known that cameras are already available with excellent sensitivity. The situation concerning projectors is not quite as clear. Two systems have been put in experimental operation: the intermediate-film method and the direct-projection method using cathode-ray tubes. Another direct-projection method has been developed at the Polytechnical Institute of Zurich, Switzerland, and has been demonstrated successfully in experimental form.

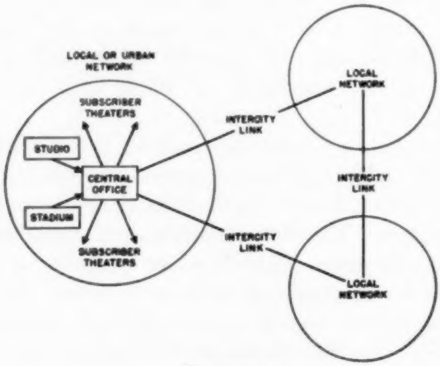

Figure 1.

The main purpose of this paper is to describe the Swiss system. I want to make it quite clear that I have no direct connection with the development of this system. That was done entirely at the Polytechnical Institute of Zurich under the direction of Professor Fischer, at the beginning of the project.[1] Since Professor Fischer's death in 1948, the project has been continued under the very able direction of Professor Baumann. I am reporting on this system at the request of Mr. D. E. Hyndman, Chairman of the SMPTE Theater Television Committee. The only justification for me to report about this system is that I saw it in operation last year in Zurich and I have taken a great interest in these developments. This paper is developed from

material prepared by Dr. H. Thiemann,[2] who is Professor Baumann's assistant and is in charge of this development in Zurich. It is through Dr. Thiemann's courtesy that I have been authorized to illustrate this paper.

If the network conception, briefly described above, is correct, both methods of theater projection, by the intermediate film or through direct projection, are necessary. At the central station office the intermediate-film process is obviously an indispensable element. A permanent record is required for retransmission to the various subscribers at convenient times. On the contrary, at the subscriber's theater there is no need for recording and therefore a direct-projection system is probably the most desirable solution. So far, the only practical solution for direct projection is to use a powerful cathode-ray tube.

How much power do we have to concentrate in the electron beam in order to illuminate the theater screen properly? For a screen of 18 $\times$ 24 ft with a luminance of 10 foot-lamberts assuming reflection conforming to Lambert's law with a coefficient of 0.7, the amount of light flux required is 6,000 lumens on the screen. If this power is projected through a refractive optical system which would have an over-all efficiency of 3%, the source would have to supply 200,000 lumens. With reflection-projection systems of the Schmidt type, one can increase the over-all efficiency to 30% and therefore the light to be supplied by the source would have to be 20,000 lumens. If the transformation from electron beams into light could be done without any loss and if that transformation could take place at the wavelengths for which the eye is most sensitive, 620 lumens would correspond to one watt in the electron beam. The power required in the electron beam would therefore be 30 watts for a transformation efficiency of 100%. The transformation efficiency is actually not more than 1% or 2%, being the product of the spectral efficiency and of the energetic efficiency. The spectral efficiency is of the order of 10% because the light produced by the electron beam is not at the wavelength for which the eye is most sensitive. The energetic efficiency of the transformation from electrons to light quanta is also of the order of 10%, resulting in a final efficiency of 1%, or perhaps 2%.

Finally, the power required in the electron beam is of the order of 3 kw. Present-day cathode-ray tubes do not handle such large amounts of power in the beam. One is, therefore, obliged to cut corners to accept a lower screen brightness, or to try to increase the re-

flection coefficient of the screen by using directive screens, or to use smaller screens.

In all cases, for large screens one has been led to the Schmidt projection system because of its great effective aperture but this system has some limitations, the most disturbing one being that the distance between the projection optics and screen cannot be increased without requiring an extreme mechanical accuracy in the projection system. Present-day practice does not allow a throw as great as the one normally used in theaters and therefore the projector cannot be installed in the normal projection booths. Improvements in cathode-ray tube projectors can be expected, but the figures quoted above show that, at best, one could hope to catch up with present-day practices in movie theaters; but the tendency is for more light and larger screens. The cathode-ray projection scheme has enough limitations to justify an attempt to look into the possibility of developing another competitive method. The fundamental philosophical objection one could raise against the cathode-ray system is that light is generated by the electron beam in the cathode-ray tube and is also controlled in the cathode-ray tube itself. Many proposals have been made in the past, based on the general idea that the light energy will be supplied from a source, such as a projection lamp, and that the intensity of the light which reaches the screen will be controlled by some independent modulation device. As far as we know, none of these proposals has been actually made to work satisfactorily, except the system using the eidophor control of Professor Fischer.

The principle of the system can best be understood with reference to Fig. 2. The light from an arc is projected on the eidophor and the surface of the eidophor itself is projected on the screen. Between the light source and the eidophor there is a slit system (or Schlieren optics), and a second one is located between the eidophor and the screen. The eidophor, which represents the control element, is a thin layer of viscous liquid deposited on a very thin metallic electrode which is transparent to the light beam. The eidophor is mechanically deformed by electrostatic forces resulting from charges which are deposited on the surface by an electron beam hitting the eidophor at a certain angle. The charge produces electrostatic stresses, and the corresponding deformation of the surface, together with the two series of slits, makes it possible to control the light flux.

The theory of the system is based on the assumption that actual diffraction with phase coherence takes place when the light crosses the

eidophor. Figure 3 represents a simplified hypothetical case where one slit only is used instead of a number of bars. In the absence of corrugation on the eidophor surface the lens forms a single image of the lower slit in the plane of the "picture slits." When regular corrugations are present additional secondary images are formed by diffraction, as shown in Fig. 3, in a manner similar to the secondary images obtained from familiar diffraction gratings. The secondary images are displaced by an angle B which depends only upon the wavelength of the light used and the period of the corrugation on the surface of the eidophor.

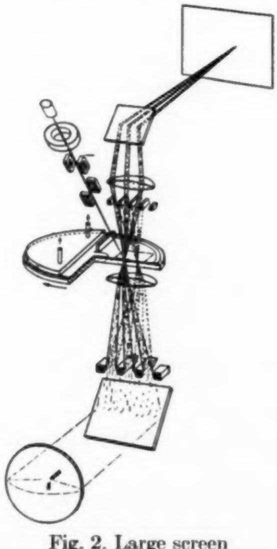

Fig. 2. Large screen television projector.

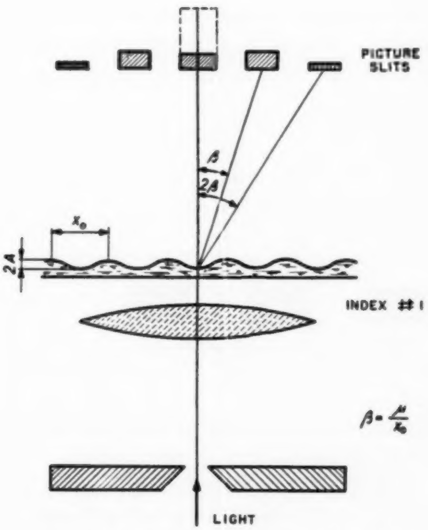

Fig. 3. Diffraction through control grids.

The distribution of light intensity in the secondary images determines the efficiency of the light control which can be achieved in this manner. This light distribution can be calculated and it can be shown that the zero order or original image can be extinguished completely while most of the light flux is shifted into the secondary images. Normally, the secondary images of the first order only are used. The study of the single slit arrangement of Fig. 3 for various forms of deformations of the eidophor surface (sinusoidal, triangular, rectangular, etc.) leads to a certain number of light control curves. A similar

study has been conducted for the extreme opposite theoretical case where an infinite number of slits are used.

From the theoretical curves thus obtained a choice of the optimum number of slits and of their geometric configurations has been made corresponding to the type of deformation occurring in a television picture. For a complete analysis of this phenomenon, which would go far beyond the limits of this presentation, the reader is referred to the original paper of Dr. Thiemann.

Figure 4 shows one possible arrangement. When the surface of the eidophor is flat, the slits are so arranged that no light is transmitted; this, therefore, corresponds to a black picture. When the surface of the eidophor is deformed with a sinusoidal undulation, the total amount of light transmitted corresponds to a white picture. A series of black-and-white lines in the picture would correspond to a defor-

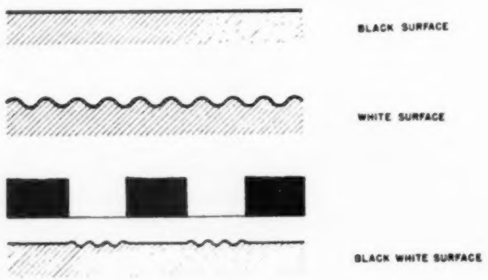

Fig. 4. Deformations on the eidophor.

mation of the surface of the eidophor which would be a flat portion followed by an undulated portion.

The period of the undulation required for a white picture has, of course, to be smaller than the duration of one picture element. In order to generate the deformation required on the eidophor, the electron striking the eidophor has to be modulated by the video signal. One possible method would be to modulate the beam intensity with a high-frequency carrier. For a white picture, the carrier would have the full amplitude and for a black picture the carrier would be entirely suppressed. This method of modulation is not the one that has been finally chosen because, the modulation curve not being fully linear, any intensity modulation is connected with some rectification. This rectification gives rise to charges on the surface of the eidophor. The charges, in turn, generate a constant deformation of the liquid surface and, therefore, an image once registered remains on the sur-

face in more or less a rudimentary form for a considerable time. In order to eliminate this cause of disturbance, a different kind of modulation has been chosen. The intensity of the beam remains constant but the scanning speed in the direction of the line is varied to conform to the video signal.

The video signal is still superimposed on a carrier which will act on the deflection of the electron beam through additional deflection plates. (The deflective voltage required is 1 volt.) In order to generate the desired deformations of the eidophor within our picture element the spot size of the electron beam shall be no more than one-quarter of the desired local period of the deformation which in turn shall be close to one-half the size of the picture element. This leads

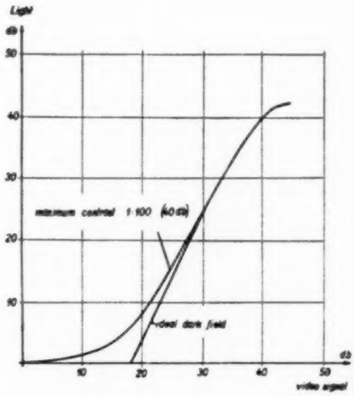

Fig. 5. Light control curve of the Schlieren optical system.

to very fine cathode-ray beams (the spot size is .001 in. in the direction of the scanning lines) and has represented one of the difficult problems of the system.

Figure 5 shows the modulation curve which can be actually achieved. The variation of light intensities is shown in a logarithmic scale *versus* the video input signal. In the curve shown, the effect of stray light has also been taken into consideration. The great importance of this stray light which prevents reaching complete black is clearly shown. Calculation of the efficiency on the complete control system shows a value to 40% for full modulation. Taking into account the fact that 50% of the light is absorbed by the slit system, the net light efficiency is approximately 20%. In other words, for a

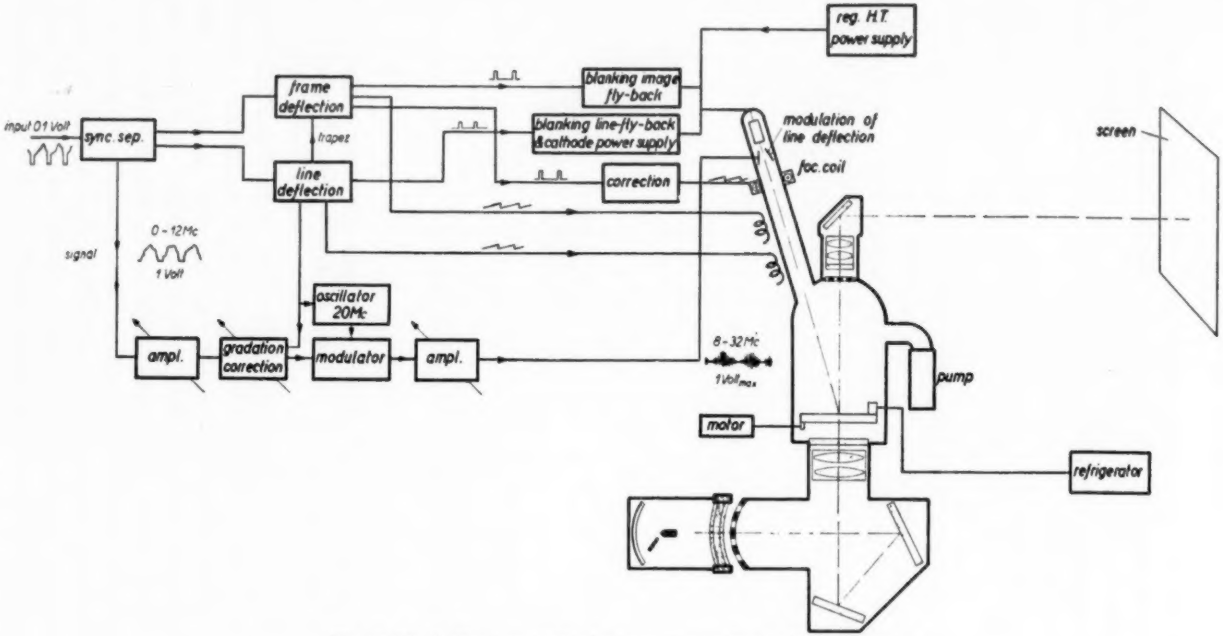

Fig. 6. Block diagram of the large screen projector installation.

light flux of 6,000 lumens on the screen, one would need an arc lamp of 30,000 lumens. For good light control the requirements of minimum stray light is not easily met. Many secondary causes may add to the ultimate amount of stray light, but the most important of all sources of remaining background light is reflection on glass surfaces. It is absolutely necessary to make all the glass surfaces within the Schlieren optics free from reflection. The laboratory equipment built at the Zurich Polytechnical Institute has met these requirements very well. Actually, one of the major qualities of the pictures demonstrated in Zurich is the excellent contrast which can be achieved combined with a smooth gradation curve. It seems to be rather superior to the pictures which can be produced with most cathode-ray tubes.

Figure 6 shows the block diagram of the large screen projector. The figure is self explanatory. The design and construction of the various electronic parts shown in the block diagram have not always been easy; but the problems they raise are of conventional nature and it does not seem necessary to present detailed comments concerning this part of the system. The preparation of a suitable eidophor liquid presents a much more difficult and original problem. The liquid has to meet very stringent specifications. Since it operates in high vacuum, its vapor pressure has to be very low, if possible appreciably lower than 10^{-5} millimeters. The conductivity, viscosity, dielectric constant and capillarity have to be inter-related by a specific relation which can be found from a theoretical study of the modulation conditions. The color of the eidophor must not have a disturbing effect. Finally, the eidophor has to withstand the bombardment of the cathode beam without being destroyed. After considerable experimenting, a suitable liquid has been found which seems to be reliable and which does not seem to be altered after long periods of operation. This is basically a mineral oil with suitable additions to bring the conductivity up to the desired value.

The arrangement as used thus far is shown in Fig. 7. The eidophor liquid is spread on a glass plate on which there is applied an electrode in the form of a transparent metallization. The glass plate moves very slowly (one turn in many minutes). After the liquid has been used for several picture frames, it is brought into contact with a cooled metal plate. After it leaves the cooling plate, it is smoothed out again by means of a straight edge or a rake into an optically perfect surface.

The movement of the eidophor is intended to permit cooling of the eidophor and to avoid disturbing border phenomena produced by

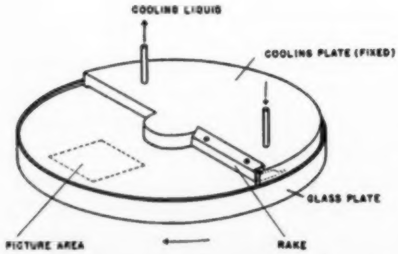

Fig. 7. Eidophor carrier with rake and cooling arrangement.

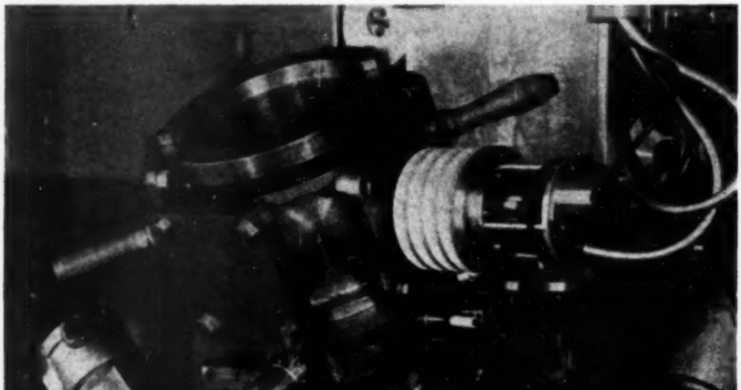

Fig. 8. Detail of the completed large screen projector: cathode-ray tube on top and center; eidophor plate holder below; holder for output slit system in back of cathode-ray tube.

electrostatic charges which would be accumulated on the eidophor if it were continuously submitted to the electron bombardment.

The various requirements briefly mentioned above for operation of the eidophor and the accuracy of the design for the optical system have led to a first experimental model which is quite complicated and is in no way intended for commercial applications.

Figures 8, 9 and 10 are pictures of some of the elements of the complete machine and show how complex and large a structure it is. The plate holder shown in Fig. 9 is approximately 6 ft in diameter. The whole machine occupies two floors, the arc lamp being at a floor below the projection room. The complexities of the present installations should not prejudice the possible future applications. Professor Baumann has worked out a project for a new model and has authorized me to present the expected over-all dimensions of this new machine, shown approximately in Fig. 11 as: height, 5 ft; length, $5\frac{1}{2}$ ft; width, $2\frac{1}{2}$ ft; and weight 1800 lb.

The great saving in size and volume as compared to the present system is due to a new conception of an optical system as it appears from Fig. 12. The light, instead of traversing the eidophor once as in the present system, will be reflected by the parabolic mirror and will return on the same slit system. Many advantages are expected from this new arrangement, such as continuous cooling by the parabolic mirror, very slow motion of the mirror (one revolution in one hour), inexpensive optical system, very high contrast ratio (1 to 300), and convenient aperture of the final light beam (1/7.4). With an arc of approximately 70,000 candles per square centimeter, Prof. Baumann expects to get a maximum light flux of approximately 7,000 lumens on the screen. Like the first laboratory model, the whole equipment will be evacuated continuously by means of a rotary pump.

From these very brief descriptions it can be seen that the eidophor-projection system, while still in the experimental stage, is progressing toward a more practical solution. The new project on which the experts of the Polytechnical Institute of Zurich are working is quite promising and would represent an equipment which in complexity and size is not very different from the latest projection systems using cathode-ray tubes. It should be noted that the Swiss system is intended for installation in the normal projection booth of the movie theater and from that point of view it has a considerable practical advantage over the cathode-ray tube systems using Schmidt optics.

To conclude, I would like to remind you once more that the remark-

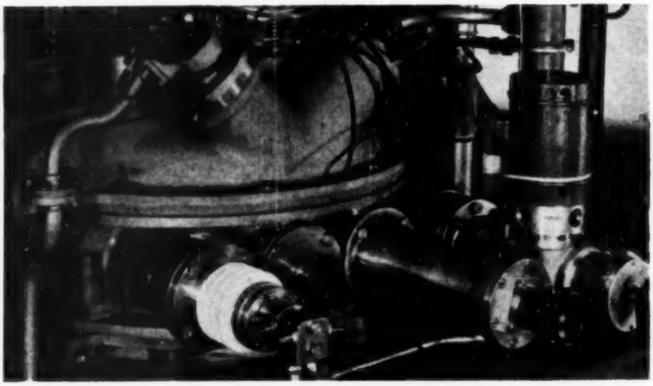

Fig. 9. Detail of completed large screen projector: eidophor plate holder at left; pumps' connection at right; cooling liquid connection at extreme left.

Fig. 10. Detail of completed large screen projector: arc lamp; optical system before reaching eidophor (eidophor holder is on floor above).

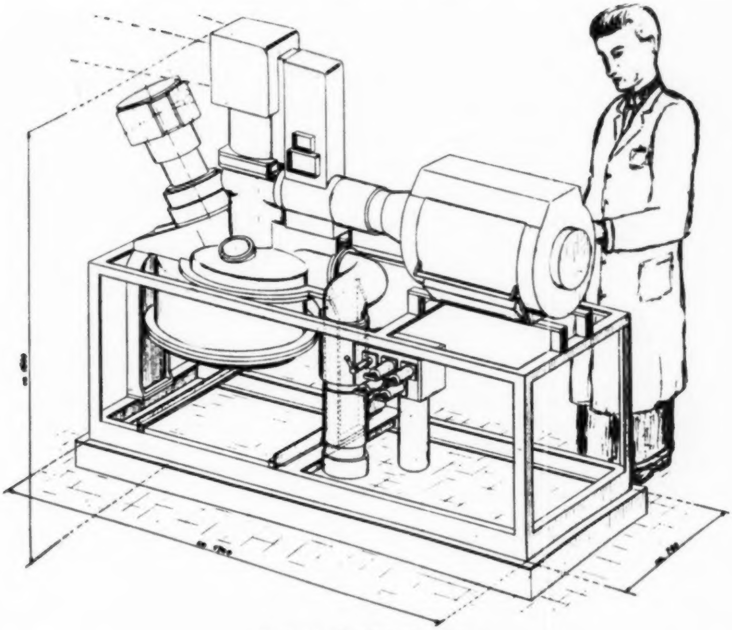

Fig. 11. Projected plant.

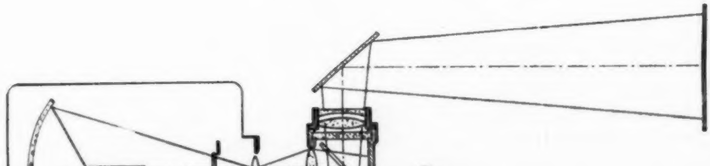

Fig. 12. Projected plant diagrammatic structure, with radar-purpose mercury high-pressure lamps.

able development which I have tried to summarize is being undertaken entirely at the Polytechnical Institute of Zurich by Professor Baumann, Dr. Thiemann and their colleagues. At the request of the SMPTE Theater Television Committee, I have tried to give a short description of this system. I do not know if it will ever be a commercial competitor for the cathode-ray tube projection system, but it would be very surprising if such a remarkable new tool would not find some useful applications. I want to thank Mr. D. E. Hyndman of the Theater Television Committee for the opportunity he gave me to talk at the SMPE Convention and I also wish to express my gratitude to Dr. Thiemann who supplied the material for this paper.

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(2) H. Thiemann, "Fernsehgrossprojektion nach dem Eidophorverfahren," *Bulletin De L'Association Suisse des Electriciens*, p. 585, No. 17, August 20, 1949; Zurich.

DISCUSSION

MR. W. W. LOZIER: Approximately what was the picture size on the eidophor?

DR. LABIN: Approximately twice the normal motion picture size.

MR. LOZIER: Can you give any lumen values of what you have obtained on, say, a white screen?

DR. LABIN: Yes, we have obtained 1500 lumens on a screen which was ten meters square. I am quoting from memory of the papers.

MR. LOZIER: Do you know approximately what speed projection lens was used, whether there are any limitations there?

DR. LABIN: No, I don't think there are limitations. They impose themselves to work with a normal angle of projection used in theaters. I mean they consider it as a must to install their machine in the normal projection rooms. It would be considered as a must, in view of the size of the machine. They have no other limitations that I see. I do not have the final efficiency in terms which would even indirectly answer your question.

MR. LOZIER: That is what I was thinking. You would have a focal length, I think, of roughly twice what we use in theaters now. If you have a picture twice as big to start with and speeds in those focal lengths might run to $f/3$ or $f/2$, will the rest of the system fill such a speed? Can it be designed to do that?

DR. LABIN: Oh yes, there is no limitation to that. If you question the actual optical efficiency of the system, it is certainly not as good as normal projection.

Standard Television Switching Equipment

By RUDY BRETZ

Television Consultant and Producer; Head of Television Dept., Dramatic Workshop and Technical Inst., New York, N.Y

Summary—There is a considerable difference in design among the standard switching systems put out by the three major television manufacturers. General engineering departments of the major networks and many of the independent stations have designed and built their own systems. All studio switching systems should permit the operator to fade to black, lap-dissolve and superimpose. Not all will permit more complicated effects such as cutting to a superimposure, or cutting away from a superimposure to a shot on another camera. Not all will permit the operator to preview a superimposure before he makes it. The following article lists the requirements of television switching systems from the operating point of view and describes the operation of the standard models which are in use in television stations today.

Switching System Design

Positioning of the Switching System

Most control rooms are laid out in a two-tier arrangement with video engineers and camera control units on the front and lower tier. The second level provides a table for the director and usually for an assistant as well. The location of the audio engineer varies between one level and the other, or he may be placed at the side of the control room, not in either tier. The bank of buttons and other controls, known as the switching system, is also found sometimes below and sometimes above. Figure 1 shows four different methods of control room layout. The technical director (T.D.) may sit at the same console as the video engineers (a), or he may sit beside the director (b, c, d). NBC (d) likes to place the video men and camera monitors off to the side and leave the T.D. and the director alone in front of the control room window. Only a master monitor and one preview

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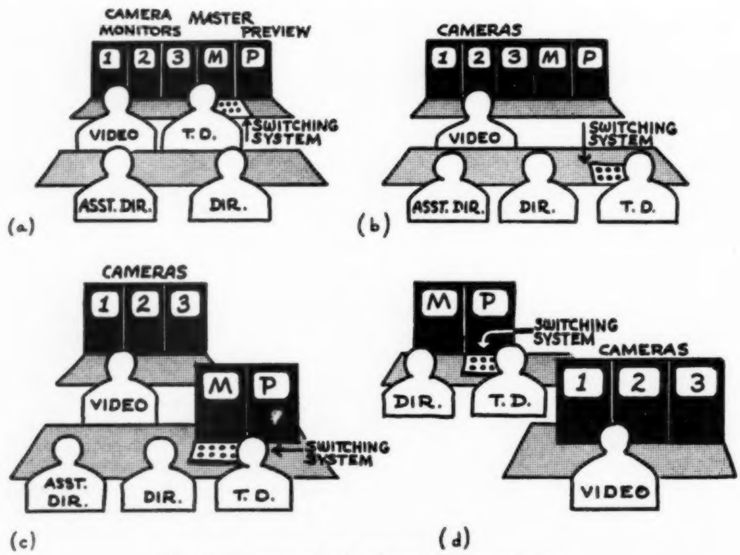


Fig. 1. Four methods of control room layout.

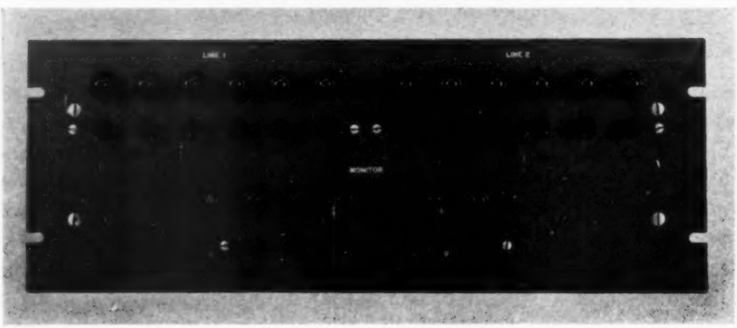


Fig. 2. RCA Switching Panel Type TS-1A.

monitor are used by the T.D. and the director under the NBC system.

The manufacturers of switching equipment usually build their switching systems into consoles, in some cases combined with a master monitor and in other cases with a preview monitor as well. The RCA studio switching system (Fig. 12), which is combined with a

master monitor in this way, can be removed from the monitor if desired. Stations sometimes mount the switch panel in the production table on the second tier, leaving the master monitor down below. Most of the specially built switching systems are installed in this manner.

In the remote truck that WBKB has designed and built (one of the best designed trucks in the industry), there are two sets of buttons: one below at the T.D.'s desk, and one on the upper desk for the producer. It is possible for the T.D. to punch a "remote control" button and throw the switching operation entirely to the director of the program, who then operates from his own set of buttons.

Incoming Picture Signals

A studio switching system must be designed to handle more incoming picture signals than merely those emanating from the cameras in the studio. Projection equipment is often used for titles or film portions of studio shows, and the film channels must also be controlled from the studio switching system. In small stations, the studio control room functions also as the film control room, sometimes actually containing the projection equipment in a back corner. In such cases, the film channel or channels normally feed through the studio switching system.

By-Passing the Studio Switching System

When a film or test pattern slide is on the air and feeding through the studio switching system, the studio cannot be used for camera rehearsal. Any switching would disturb the program on the air. For this reason, there is always some means provided for by-passing the studio switching system and feeding directly from film camera to transmitter. The same by-passing is provided for other incoming signals, such as network programs from AT&T (if the station is on the coaxial cable), or a picture from a remote pickup. A series of master switching buttons is installed for this by-passing purpose, in the circuits between the studio switching system and the transmitter. Sound, of course, must be handled identically, but audio is a parallel system and not the concern of this chapter. Figure 3 shows the master switching panel for by-passing the studio switching system. Buttons shown in black are on. The film camera is feeding through the by-pass circuit directly to the transmitter, while the switching system is feeding only the client's booth and monitors.

Preview Switching

It is always a great risk to put anything on the air without being able to watch it right up to the moment of the switch. Any picture which does not appear on a camera-control monitor in the control room must be previewed somewhere before being switched onto the air. Film channels which are monitored and controlled elsewhere will have to be previewed in this way. When remote pickups are to be integrated with studio presentations, they also must be previewed.

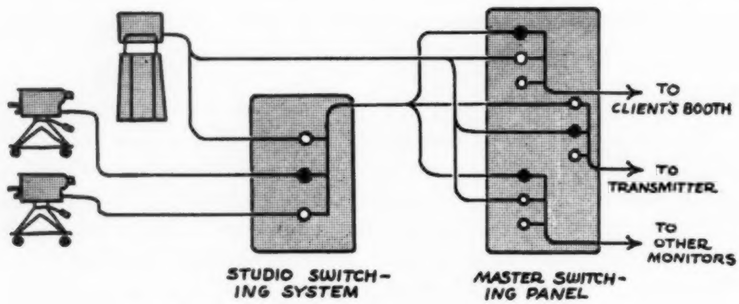


Fig. 3. Method of by-passing studio switching system.

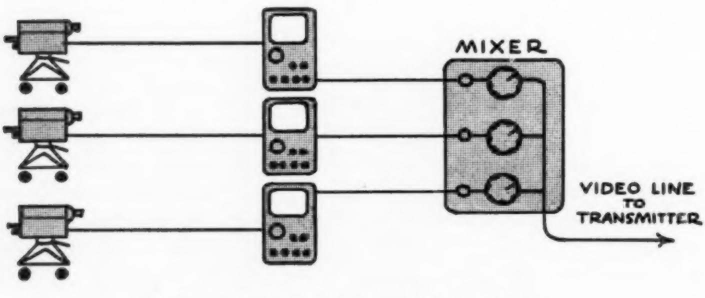


Fig. 4. Mixer type of switching system.

This is particularly true on occasions when live or film commercials from the studio must be inserted into ball games or other sports events. At these times, the ball game will sometimes be fed through the studio switching system on its way to the transmitter, so that the studio-originated portions can be cut in. Any good switching system must provide a method of selecting the channels that are to be seen on the preview monitor.

Some switching systems, which have a master monitor built into the same unit, make it possible to use the master monitor for previewing these incoming lines. This is a poor practice, however, since it sacrifices the master monitor during the time another channel is being previewed. It results in a type of previewing which amounts to only a quick glance at the next picture, and it certainly is not desirable for best programming results.

Dissolves

A switching system must also be designed to fade channels or cross-fade them so that dissolves, fades and superimposures can be accomplished. There are three common ways to design a switching system to do these things.

1. The Mixer Type. The first system provides each channel with a separate gain control, and runs them all together into a mixer, just as the outputs of many microphones are mixed in an audio console. This kind of switching system may have separate switches, as well as separate fading controls. The old Mt. Lee studio of KTSL had such a switching system, built according to the studio's own design. It had seven positions for fading, but no switches. Instantaneous cuts had to be approximated by very quick dissolves. The Dumont "mixer," which is a switching system of this general type, provides for only four channels, but has switches and a number of additional features and refinements (Fig. 4).

2. The Dual-Fading-Bus Type. The second type of switching system provides two basic master channels, which feed through two fader controls. They are usually termed "channel" or "fading bus" A and B, and all of the video channels which feed into the switching system can be punched up on either one (Fig. 5).

Only one of these two channels is used when straight switching is desired; the fader control for the channel being used is left open and the fader control for the other is closed. If you have been using Channel A, for example, and wish to make a dissolve, first punch up the camera you will dissolve to on Channel B, then simultaneously fade out Channel A and fade in Channel B. There will be a further discussion of this later in this chapter under "Specific Equipment." The RCA studio switching system is of this design, as well as the General Electric switching system which is built into a program console.

3. The Three-Bus Type. The third system has three master channels, two of which are for fading and dissolving, as just described, while the third is used for straight switching. The straight switching bus has an extra button marked "Effects," through which the combined output of the two fading buses will feed whenever dissolves or superimposures are desired. This has an advantage over the second

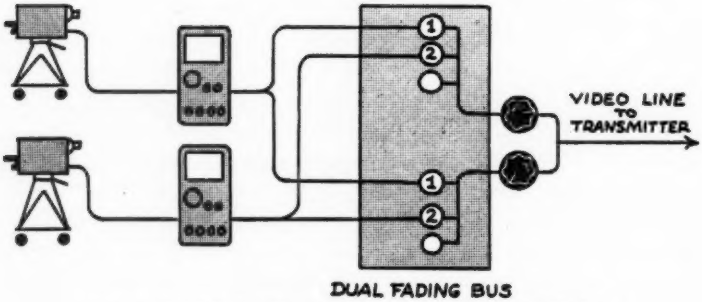


Fig. 5. Dual-fading-bus type of switching system design.

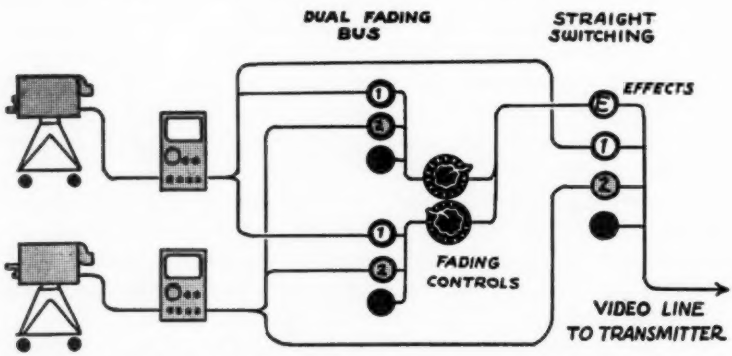


Fig. 6. Three-bus type of switching system design.

type of switching system in that it permits switching to a superimposure or switching away from a superimposure to a single camera (Fig. 6).

This type of switching system was developed by NBC and has been installed in all the NBC-owned stations. The RCA switching system, which is built into the Program Director's Console, is of this design. CBS has made some very useful additions to this equipment.

SPECIFIC EQUIPMENT; HOW TO OPERATE SWITCHING SYSTEMS

The RCA Field Switching System

The RCA Field Switching System, first on the market in 1946, is very frequently seen, not only as remote equipment, but in studio use as well. This equipment originally had no provision for making dissolves, and several ingenious devices have been developed to adapt it to this purpose. RCA now offers a special auxiliary unit which is equipped with dual fading buses similar to the RCA studio switching system (Fig. 7a).

The control face of this switching system is divided into three horizontal areas. At the top is a bank of 13 switches which control a very complicated and flexible intercommunication system, described in detail in the chapter on intercommunication. Beneath the cover in the middle portion is an intercom jack panel, containing six plug-in points for the engineers' and director's headphones.

The lower third only is concerned with switching of picture signals. There are two rows of buttons with associated tally lights to show which channel is on the air. The top row is for monitor switching and the bottom row controls the outgoing picture line. The monitor-switching feature, as explained above, makes it possible to use the master monitor as a preview monitor when working with limited equipment. The master monitor is, of course, a separate unit.

Six incoming signals are provided for in this switching system. Four of these are intended for camera channels and two (auxiliary 5 and 6) for incoming channels, usually from a remote source.

Monitor switching allows the master monitor to be used for several purposes in addition to its regular use as a master monitor on the outgoing picture line. Either of the incoming pictures lines, 5 or 6, can be previewed by punching the appropriate buttons. The engineer has occasional need for checking the picture at various points in the system—for instance, at the input and output of the relay transmitter—when this equipment is being used in field pickup; provision is made for these purposes also. In actual practice, on a remote pickup, monitor switching is used only in case of emergency. It would be extremely confusing to a director not to know if the picture being shown on the master monitor is on the air.

The knob above the monitor switching buttons is concerned with the two auxiliary lines 5 and 6. When a picture is coming in from a remote source, say another studio or a field pickup, the equipment in

Fig. 7a. Control panel of RCA Field Switching System, Type TS-30A.

that location probably includes its own synchronizing generator, and the incoming signal is a composite signal; that is, the synchronizing pulses are already combined with it. In the case of the camera channels, the signals coming in to the switching system are pure video, and the synchronizing pulses are added in the switching system just

before the program goes out to the transmitter. When the incoming signals on lines 5 and 6 are complete with synchronizing signals, the switch knob is set to EXT (external sync). If, instead, picture signals from additional cameras or film pickup chains are fed through the auxiliary lines, these are not composite signals and synchronizing signals must be added. For this the switch is set to INT (internal sync).

Dissolves with the RCA Field Switching System. The TS-30A switching system provides for straight switching only, since when it was designed in 1945 no one anticipated the need for dissolves or superimposures in the field, and studio use of this equipment was not contemplated.

A great many small stations have installed this field equipment in their studios, however, because of its low cost. Naturally, the requirements of studio production make dissolving, at least, a necessity. In the field an even greater use has been found for the superimposure than for the dissolve. During brief intermissions in a game, the director may want to show the sponsor's name or symbol on the screen as a visual complement to a short commercial, without at the same time giving the audience the feeling of losing contact with the field, where action may begin again at any moment. In such cases, a superimposure is very valuable. A very striking effect is often achieved by superimposing a close-up of a beer bottle, for instance, on the baseball field in such a way that it looks like a gigantic bottle actually resting on the field. Perspective must match to achieve this.

It is possible, with a little co-ordination between video engineer and technical director, to use the equipment as it now stands to effect a very credible dissolve. It has been found that two of the video switching buttons can be depressed at the same time, putting two signals on the air simultaneously. The result of this is, of course, a sudden superimposure when the second channel is added, an effect which is very rarely of any value. But if the second channel is added in a faded-down condition, and then the gain brought up after it is on the line, a slow appearance of the superimposed shot is effected. If the first picture is faded down at the same time that the second picture is brought up, a dissolve is the result. The gain controls are not associated with the switching system, but are found on the camera control units. Consequently, a very exact co-ordination is necessary between technical director and video engineer to make this result

possible. I have seen it done by one man in the studio at KTSP-TV, where only one engineer was available for all the video functions (Fig. 7b).

The routine, with the proper director's cues, is as follows:

1. "Fade down Two." (Assuming that Camera One is on the air, the desired shot is framed up on Two and the cameraman is told to hold it, while the instruction to fade down is given.)

2. "Add Two." (Camera Two is punched up on the switching system, but Button One must be held down, so that it won't automatically switch off since all buttons in each row are mechanically interlocked. Since Two is now faded down, there is no visual effect except a slight tonal change due to the added circuit.)

3. "Dissolve." (The dissolve can now be effected by simultaneously fading down the gain on One and fading up the gain on Two.

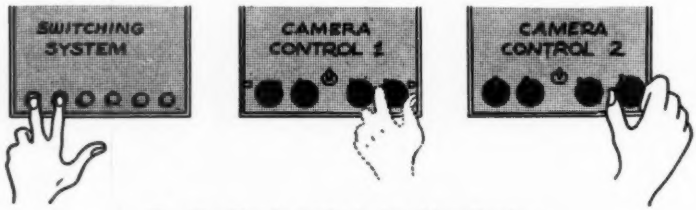


Fig. 7b. Simple method of making dissolves with RCA Field Switching System.

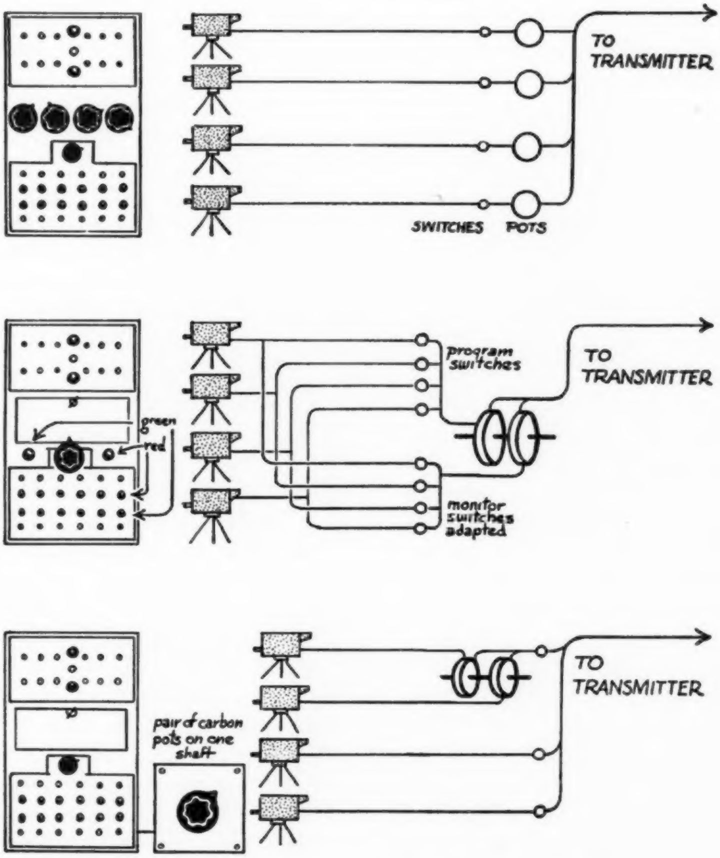
To be properly co-ordinated, this must be done by one person, and of course, he must watch the master monitor during the process. It may be found, for instance, that it is best to fade in Two about halfway before starting to take One out, or a dark period will be noticeable in the middle of the dissolve.)

4. "Drop One." (It is now necessary to take Camera One off the line, before any cuts are made, unless a dissolve back to One is expected. To take out One, Button Two must be held down while one of the other buttons is depressed just half way, far enough to trip the automatic release which snaps out Button One.

5. "Fade up One." (When the dissolve was effected, Camera One was faded down to black; before it can be used again, the gain must be turned up. This final step is frequently forgotten in learning this method of making dissolves.)

A strange effect is noticeable on the camera monitors when two switching system buttons are held down. The picture from each

camera feeds back through the line from the other camera and appears on that camera's monitor as well. This is not noticeable if the above routine is carried out properly, since one camera is always faded down while two buttons are depressed.



Figs. 8, 9, and 10. Adaptations of RCA Field Switching System to permit dissolves.

Special Adaptations of the Field Switching System. The method of effecting dissolves just described requires more co-ordination between various operators than most television stations like to rely on.

A self-contained switching and dissolving unit is much simpler to operate.

One method of adapting the field switching system for making dissolves was devised by WENR-TV in Chicago (Fig. 8). That station mounted separate potentiometers (fading dials) for each of four channels in the space where the intercom plug board is located. This method changed the switching system to a mixer type of dissolving system, similar to the Dumont mixer. The intercom facilities were, of course, sacrificed, but that was not serious, since most studios prefer to use their own separate intercom systems.

A second method is to convert the equipment into a dual-fading-bus type of switching system; one bus is the regular set of program selector switches, the second bus is the set of monitor selector switches. A separate potentiometer can be connected to each of these fading buses and mounted on the face of the switching system, or two potentiometers can be mounted face to face on one shaft, so that they work in opposite directions and only one dial is necessary. With two potentiometers on a single shaft, however, all that can be accomplished is a dissolve, since one channel fades in as the other fades out. With separate control, fade-outs and superimposures can also be effected (Fig. 9).

A third method is to feed only two channels into a separate dissolve control. This method may make use of a pair of potentiometers on the same shaft, or two separate dials, mounted in an auxiliary box. A certain number of studios are equipped with complicated versions of this "dissolve box," some containing separate dual-fading buses and camera-selector switches. The most common dissolve box, however, is rigged up to handle only two channels. It is very simple to install and at least 80% of the dissolving or superimposing needs of field programs can be met if only two channels are available (Fig. 10).

RCA now offers an "Auxiliary Field Switching Control" which operates in the same manner as their studio switching system described below. Since this is a separate box, it can be remote from the switching system if desired. Six channels may feed through this switching control which then feeds into the "Aux 5" button on the switching system. Five inputs are still usable on the switching system, in addition to the six that the auxiliary unit provides. A total of eleven local signals may be handled (six of which can be faded) or any combination of local and incoming remote signals may be used up to a maximum of seven remote and four local. This unit greatly expands the usefulness of the field switching system.

The RCA Studio Switching System

This equipment is often seen in both large and small studios. It is a dual-fading-bus type of switching system and is built into a unit with the master monitor. It is possible to remove the switching system from the monitor, however, and this has been done in some studios to allow either the T.D. or the producer to push buttons from the production desk.

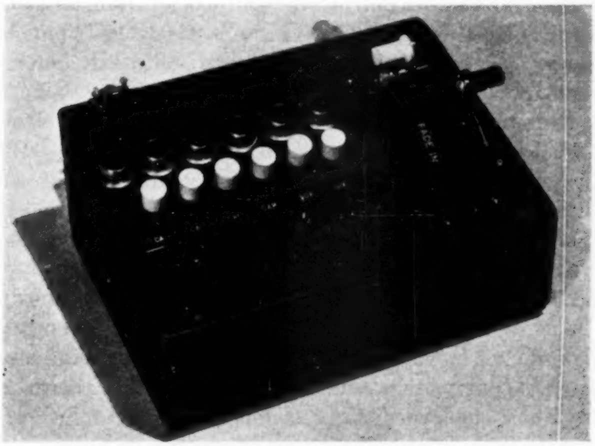


Fig. 11. Auxiliary field switching control.

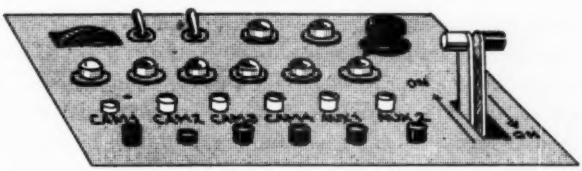


Fig. 12. RCA Studio Switching System.

Basically, this switching system is built around two rows of buttons, each feeding a fading bus. The two fading buses are controlled by levers which can either work separately to fade out one bus and fade in the other, or, as is more often the case, the levers can be clipped together to operate simultaneously for lap-dissolves.

In Fig. 12, the two lower rows of buttons are connected to the two

fading buses. The white row may be faded by the white handle, the black row by the black handle. Above the two rows of switches is a row of tally lights that show which channel is on the air. The tally light does not indicate which fading bus is operating; the position of the fading handles shows this.

Straight switching between cameras can be done with either bank of push buttons, providing the fading control for that particular bank is open. The signal from Camera One, in other words, is carried to *both* Button One on the white row of buttons and to Button One on the black row. When White Button One is punched, the signal goes onto the white bus and through the white fader control, if that control is open. If a dissolve is desired to, say, Camera Two, Button Two must be preset on the black row (since the black fading control is closed, nothing happens to the program line). When the moment for the dissolve comes, the white bus is faded out (with White Button One depressed) and the black bus is faded in (with Black Button Two in the ON position). The two fading dials work in opposite directions; that is, the ON position for the white handle is at the top, and the ON position for the black handle is at the bottom. Thus at the beginning of the dissolve, both levers will be at the top, and so it is possible to work them with one hand and simultaneously fade one picture out and fade the other in (there is a spring clip with which the levers can be fastened together).

Superimposures. The halfway condition in a dissolve is a superimposure, and the handles may be left in the midway position if desired. Each camera is then at half brilliance. This does not always make the best superimposure, however. Sometimes it may be necessary to superimpose a ghost onto a scene without making any noticeable change in the scene itself. The second camera, with the image of the ghost, must be added to the first, without lowering the level of the first signal. In this case the two handles are separated and the second one is brought up to the desired brilliance without lowering the first. Some operators like to keep their fading handles separated at all times, feeling that they thus have better control.

Cutting to or from a Superimposure. The manufacturer of the RCA switching system says nothing about achieving this effect. It is not supposed to be possible, in a switching system composed of two fading buses, to tie up both in a superimposure and then switch to another shot. There is nothing left to switch to; everything is in use. If another camera were punched up on either of the fading buses, the

new picture would simply take the place of one of the other camera signals within the superimposure. One of the cameras must be lost from the superimposure before straight switching can be done. The same is true in getting into the superimposure. A straight shot must be taken first and the superimposed picture added; the two cannot appear at once. Technical directors with skill and ingenuity have discovered ways, however, to operate this equipment and effect a cut to a superimposure or away from a superimposure to a single shot.

A practical problem like this sometimes arises: A girl enters a room, sees a ghost, and speaks to it. If the ghost were to materialize slowly before the girl's eyes, the problem would be easy. But the ghost must be *in* the room as soon as we see it. We must then cut from the room-and-ghost shot to a shot of the girl as she speaks.

One method of doing this is as follows: Camera One takes the girl as she enters the door, Camera Two, the room, and Camera Three, the ghost (an actor in another set, brightly lighted against a black background). Camera One is on the air. If One is punched up on, say, the top row of buttons, punch it up also on the bottom row and set the handles halfway. Half of the Camera One signal is then coming through one fading bus, and half through the other. Now place one finger on Button Two in the top row and a second finger on Button Three in the bottom row, and press them both at once. Of course, there has been no way of previewing the superimposure. You are cutting blind, so to speak, and, unless you rely heavily on the cameramen to mark their finders during rehearsal and repeat the exact framing they had then, you will not be quite sure whether the ghost will seem to be standing next to or inside the furniture, with his feet on the floor, or floating several inches above it. To cut away from this superimposure back to Camera One again as the girl speaks, simply press both Camera One buttons at once.

A second method of doing this is a little more difficult. With Camera One on the air as before, punched up on the top (white) row of buttons, a cut to a superimposure of Two and Three is desired. In this case, preset Black Button Two and hold a finger ready on Button Three in the white row. Both fading handles will be in the top position as shown in the illustration. At the same instant, press Button Three in the top row and bring the fading handles down halfway. To cut back again to Camera One by this method, simultaneously punch Button One in the top row and bring the fading handles to the top.

RCA Program Director's Console

This switching system is similar to the one just described except that it is built into a console containing three monitors, intercom controls, talk-back microphones and working table space for three. The table is for the T.D., the program director, and his assistant (Fig. 13).

An unusual feature of the monitors is that they are mounted vertically in the cabinet below the table and are viewed through a mirror.

Fig. 13. RCA Program Director's Console.

This permits the top of the console to be very low, making it possible for the director and the T.D. to see the camera control monitors and into the studio from a seated position.

This equipment is used in a number of ways. Some studios mount the maximum of five monitors in the console, so that the director may have the three camera monitors in front of him, with a master monitor and a preview screen as well.

The manufacturer intended the three screens to be used for: (1) preview; (2) studio switching master monitor; and (3) on-the-air master monitor. The difference between a studio switching master monitor and an on-the-air master monitor is a little obscure to the average production man. The engineer will use the studio switching monitor to show the results of operating the studio switching system, and the on-the-air monitor as a check on the condition of the picture farther on in the circuit and as a cue monitor.

In actual practice, the two side screens are most often used as preview screens, but the exact use of the console is a matter of personal preference. Some directors at CBS use it only in connection with the regular camera control monitors, which they can watch down beyond as in Fig. 1 (c). They use the left preview monitor only for film, the right only for still pictures. Even with three studio cameras, I have found it quite satisfactory to do the entire show without referring at all to the camera control monitors. The middle screen is a studio switching monitor. Camera One is always previewed on the left; Camera Three always on the right. When One is on the air, Two is found on the left monitor; when Three is on the air, Two is found over on the right. This is really not as confusing as it may at first seem, since each monitor has a series of numbered tally lights above it, and it requires but a quick glance to read what picture is displayed on each monitor. This previewing of camera channels is established as an automatic procedure to be followed by the T.D. without orders from the director. Channels other than these three camera channels can be previewed on either monitor at the director's request.

Switching System. Switching allows for a maximum of 12 different inputs in this console. Small stations will not utilize all these positions, but in a large network studio all may be needed. CBS, for instance, has five film channels in the projection room, and also a monoscope channel with test pattern. Any of these might be needed for a studio show, so that all must feed into each studio switching

system. A possible maximum of four studio cameras (five have been used on complicated shows) brings the total number of channels to ten. One channel must be used for the incoming cue line, which is necessary in a network studio and shows the on-the-air network program at all times. It is previewed by the studio control room just before going on the air so that in case of an error in timing, the show can wait until the line is clear. All of this leaves only one channel for a spare (Fig. 14).

The dual-fading-bus method of dissolving is used. One bank of buttons is white, and is controlled by a white fading handle; the other bank is black, with a black handle. The two fading controls work opposite to each other so that when they are moved simultane-

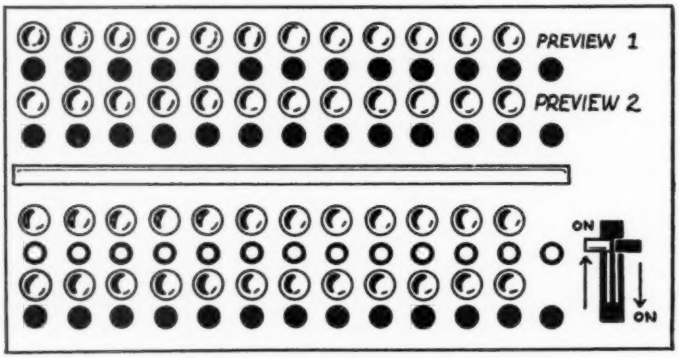


Fig. 14. Push-button panel used in RCA Program Director's Console.

ously, one bus is faded out, the other in, and a dissolve is effected. This is almost identical with the RCA studio switching system. Two banks of push buttons at the top of the panel control the two preview monitors.

CBS Adaptations from the RCA TC5A Switching System. Figure 15 shows how CBS has simplified this switching panel, and added another row of buttons. Instead of having a row of tally lights above every row of buttons, they have used a plastic button which is itself a light, and lights up as soon as it is punched; hence the simplification. The added feature is a row of straight switching buttons not connected with the fading buses, and not controlled by either fading handle. Figure 6 shows the relationship of these buttons.

The advantage of this is that one can cut to or from a superimposed effect. The last button (the 13th) on the row of straight switching buttons is labeled E, for "Effects." When that button is punched, the output of the fading buses goes out the program line. Thus it is possible to preset this entire effects system and preview the combined picture, and for this purpose an effects button is included in each row of preview buttons. To cut away from a superimposure, the next take is punched up on the straight switching bus, and the effect buses are dropped.

The only disadvantage in this type of switching system is that the director must give the T.D. sufficient warning before calling for a dissolve. If the cuts are being made on the straight switching bus,

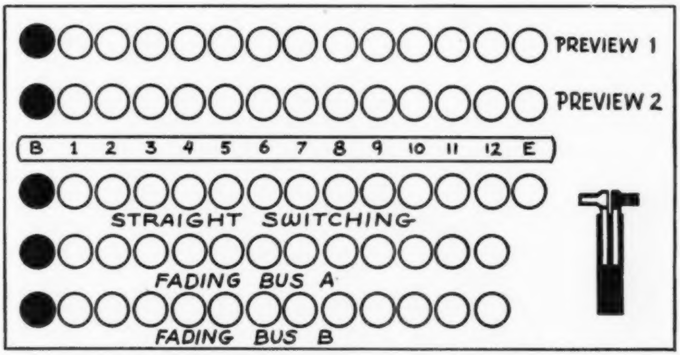


Fig. 15. CBS adaptation from RCA push-button panel shown in Fig. 14.

for instance, the T.D. has to bring the fading buses into operation before he can make a dissolve. To do this, he presets the same channel that is on the air on one of the fading buses and punches the E button in his top line. No effect will be seen and he is then ready to preset the other fading bus for the channel he is to dissolve to, and to make the dissolve. This does make dissolving a little more difficult, but it may well be a good thing, in the light of the great amount of meaningless, unnecessary and disturbing dissolves used in television today. Dissolves have been much too easy to do. A switching system which sacrifices some of the freedom in dissolving for added flexibility in other directions is, it seems, built to a good design.

An extra button has been added by CBS at the far left of each row

This is the black button (no signal). It is easier to make a fade-out by dissolving to black rather than by fading out one channel. The two fading handles are thus kept working together, which eliminates certain possibilities for error.

The Dumont Mixer

Dumont manufactures only field equipment, but it is frequently

Fig. 16. Dumont Mixer.

used in the studio. The field switching system particularly is well adapted to studio purposes. It is a mixer type of switching system, with separate fading dials for each channel. The manufacturer labels it "Mixer-Amplifier and Monitor," in recognition of the other functions incorporated into the same suitcase unit (Fig. 16).

Starting at the bottom of the mixer control panel, there is, first, a series of four tally lights for the four channels this equipment can handle. In the center of this row is an input socket for plugging in the T.D.'s earphones and talk-back circuit. Just above are the four fading dials, and above each of these is a push button switch. These four switches are mechanically interlocked so that if all faders are left open, straight switching can be done.

An unusual feature of this switching system is an automatic fade and dissolve, which can be actuated by these same buttons. Above the fourth push button is a dial marked "Auto Fade Rate." If this dial is set at "Instantaneous," pushing the channel buttons results in straight switching.

If the automatic fade dial is set on any of the other three positions (slow, medium or fast), a lap-dissolve or a fade-out–fade-in will be made. A small toggle switch to the left of this dial selects either the lap or the fade effect. The only manual control necessary is punching the button for the new channel; the dissolve or fade-out–fade-in then proceeds automatically at the selected speed. A fast lap is completed in $1\frac{1}{2}$ sec; medium speed is 3 sec; and a slow dissolve takes 5 sec. The fade-out–fade-in proceeds at about the same speed as the dissolve.

Manual Operation. Since the automatic dissolve cannot be halted at a halfway point for a superimposure effect, another method of operation has been provided. In the middle of the row of camera switching buttons, divided from them by a white line, is a button marked "Manual Mixing." Punching this button throws all the other buttons into the ON position. Control is then exercised only by means of the fading dials.

During automatic switching all the faders must be open, but the switching buttons are interlocked, and only one channel at a time is switched into the mixer. When the manual button is punched, however, all the channels are switched into the mixer and will all go out at once as one big superimposure, unless their fading dials are first turned to the OFF position.

The transition from automatic to manual operation is usually made in this fashion: All the faders are turned down except the one controlling the channel which is on the air. The manual mixing button is then punched. There is no effect on the program picture, since all that the manual button has done is to turn on the other three switches. It is now possible to fade, lap or superimpose to any extent and at any speed, since everything is under manual control. If at any time a cut is desired, automatic cutting must be restored by punching the switching button of the channel that is on the air. No effect is seen, but all the other switches are then turned off. However, the faders also are off and must first be turned up before a switch between channels can be achieved.

Here is the routine again, applied to a simple example: Starting with Camera One, on the close-up of an actor, it is desired to cut to Two, on a long shot of the room, then superimpose a ghost with Camera Three, lose the superimposure and cut again to One.

Director's Cue	*Technical Director's Action*
1. "Take Two."	Checks to see that the automatic fader is set at INST. Punches Button Two.
2. "Ready to superimpose."	Turns down all dials except No. Two. Punches manual button.
3. "Superimpose Three."	Turns up No. Three fader.
4. "Lose Three."	Fades down No. Three fader.
5. "Ready to take One."	Punches up No. Two button. Turns up all faders.
6. "Take One."	Punches No. One button.

The method of operating this equipment usually is as follows: The right hand is kept on the automatic fader, ready to turn it to INST if the director calls for a take, or back to one of the other settings, according to the director's "ready" cue. The left hand is used for punching buttons and working dials on the first two channels. The right hand generally handles the third and fourth channels. If the director is not careful to give "ready" cues, however, he may call "Take" and get a dissolve (a very frequent phenomenon where this equipment is used). In general, it may be said that the automatic

dissolve feature increases the ease with which dissolves and fades can be made and leads to an over-use of these effects.

Cutting to or from a Superimposure. While the direct cut into or out of a superimposure was not intended as part of the function of the Dumont mixer, it is possible to achieve this effect by one of two methods.

The simpler method is to punch two buttons simultaneously. The T.D. must mark the position of each fading dial during rehearsal, and set them thus before the switch so that the balance between them will be correct. It is often found desirable when two channels are punched up at the same time, to leave the fading dials full open and regulate the balance between the two pictures by riding the pedestal controls on the camera control units. This requires either very close co-ordination between the T.D. and the video engineer, or close proximity of mixer and camera control units so that the T.D. can operate both. Cutting from a superimposure to another camera is very simple when using this method; punching up the new camera will automatically release the previous two.

A second method makes use of the manual button (which throws all switches into ON position at once). The T.D. opens the two fading dials that control the cameras which are to be superimposed and then punches the manual button. The cameras will go on the line simultaneously. Automatic switching is no longer in effect, however, and the first switch will not automatically snap off. Unless the first camera is quickly faded down when the switch is made, there will be three picture signals on the air.

To cut from the two superimposed cameras back to the single shot again, the T.D. simultaneously punches the button that controls this camera and turns up its dial. Punching the camera button throws the system into automatic switching and both the superimposed cameras are dropped from the line as the new camera is switched in. Since the fading dial for this camera had been closed before, it must now be quickly opened so that the signal can feed through.

To Delay a Fade-In. Sometimes a program will require a longer fade-out–fade-in than the automatic slow rate of 5 sec. In this case, the T.D. may punch the fade-out and quickly turn down the dial of the new channel so that the automatic fade-in will have no result. Then, when ready, he will fade in that channel manually by turning up the dial. Another way to do this is to make an automatic fade to black. Since the automatic fade effect always includes a fade-in

after the fade-out, if the picture is to stay black, the new channel must be a dead channel. The T.D. will turn down the fading dial on a channel which is not in use, set the auto-fade dial and switch, and punch the button for that dead channel. The live channel will fade out, the dead channel will "fade in" and the screen will remain black. Then, when he is ready to fade in the next picture, he will punch the appropriate button. The mechanism then makes a second automatic fade; the dead channel automatically "fades out" and the new picture fades in.

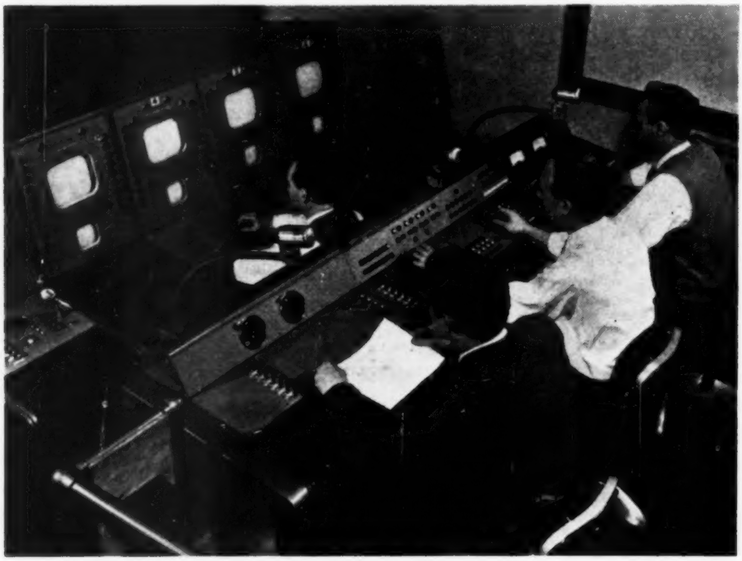


Fig. 17. General Electric Program Console.

Dissolving to a Superimposure. This is an effect which cannot very easily be accomplished on any standard equipment except the Dumont mixer. At the mid-point of this effect three cameras must be on the air at once. When the system is set for manual mixing, it is possible to fade down a dial with one hand, and fade up two more simultaneously with the other. This can be done, however, only if the two dials which are to be opened simultaneously are next to each other on the board. Technical directors with three hands are difficult to find.

General Electric Program Console

The switching system manufactured by General Electric is built into a console which seats three, the director, the T.D. and the audio engineer. Figure 17 shows this console in operation at WGN-TV in Chicago. General Electric has just placed on the market a new model which is part of its new line of television equipment. As far as its operation is concerned, however, it is reported not to differ greatly in any basic way from the console and switching system described herein.

From the standpoint of production, this is a beautifully conceived piece of equipment. Everything has been thought of and built in, even to telephone handsets at each position and recessed ash trays. All that need be added is a script and the inevitable container of coffee.

Monitors are not included in this console. It is intended for use with the General Electric Camera Control Desk, which includes large monitors, relatively high, so that it is not difficult for the director to watch them over the video operators' heads. The console can be used in the dark (a desirable condition where monitors are not hooded to keep off stray light). Every control label is printed in fluorescent paint, which glows brightly when the console is flooded with ultraviolet (black) light. For the illumination of scripts, a small white light is built into the bottom of each gooseneck microphone mount, which is adjustable to any angle.

The director's position on the left is equipped with a clock and built-in stop watch, plus a variety of intercommunication switches which can be hooked up to whatever combinations of circuits are desired. A disadvantage of this console is the lack of desk space for an assistant director. The assistant must work at an adjoining table or pull up a chair to the side and work without desk space.

The audio operator's console at the right is equipped with a five-position mixer (five fading dials), with two outputs. Operating experience has shown that five positions are too few in television, especially in a large studio. Each source of sound requires a separate potentiometer in general practice; and although there are ways of circumventing this, they are not very satisfactory. A further discussion of this point is to be found in the chapter on audio equipment.

The switching system in the center of the program console is of primary interest at this point (Fig. 18). It is a dual-fading-bus type

with the push buttons arranged in two banks, one for the left hand to operate, one for the right. Six inputs are provided. All of these may be used by cameras, or some may bring in film or remote signals. The method of operation is similar to that of the RCA studio switching system. Straight switching is accomplished by punching buttons in whichever fading bus happens to be in use. Two fading handles control the two fading buses. These handles are mechanically interlocked so that it is possible to make a dissolve by operating only one handle, the handle controlling the bus which is to be faded in. When this handle is faded in, the other automatically fades out. The interconnection does not function, however, when the handle of the fading bus that is on the air is operated. As this bus is faded out, the other will not automatically fade in, which makes a fade-out to

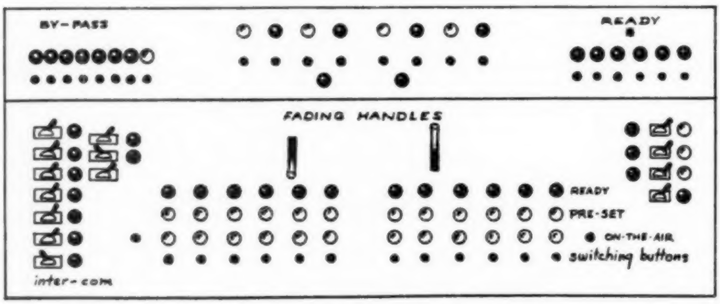


Fig. 18. General Electric Program Console switching system.

black possible. A superimposure can be made by stopping the handles halfway. Two channels cannot be superimposed at full strength, however, since bringing up the second handle automatically brings down the first one. This limitation makes the mechanical interlock feature a disadvantage in making superimposures.

Above each push button is a series of three tally lights, the top one green and the other two white. The bottom white one lights when the channel is on the air, and shows which channel is on and which fading bus is in use. The middle row of white lights is marked "Available" and indicates the channel that has been preset. These lights work on the fading bus which is not in use but is preset for dissolves. The green lights on the top row are preview or "ready" indicators. A light in this row shows that the T.D. has punched the proper one of a series of ready buttons which are placed on the top of

the console on the extreme right. When one of these ready buttons is pushed, a green ready light goes on in the camera and on the camera control unit and, at the same time, the green tally light, which was just described, goes on in the switching system. The two top lights, then, should be on before a dissolve is made, after which the bottom light is then added. Verbal ready cues are very helpful, but this ready-light system seems to be an unnecessary complication and I have not seen it utilized very often in actual practice.

Cutting to or from a Superimposure. There are two ways to do this on the General Electric switching system. The first method makes use of the built-in by-pass control. A special set of buttons (top row, far left) makes it possible to select any particular incoming signal and circuit it around the switching system. This is used, for instance, when a film is on the air (which would normally feed through the switching system), and a studio show must be rehearsed at the same time. It eliminates the extra switching panel which is used for this purpose with RCA equipment. This bank of by-pass buttons may be used for straight switching if desired.

Buttons on this bank control incoming program lines such as film channels and network line, and one button controls the output of the switching system. If the individual studio cameras are also fed through by-pass buttons, a camera may feed its signal to the transmitter without passing through either of the fading buses. The operator is then free to punch up two cameras on the two fading buses, set a superimposure, and cut to it by punching the switching system button on the by-pass bank. This button serves the same purpose as the E (Effects) button on the CBS modification of RCA's director's Console. The operator of the General Electric switching system may also preview this superimposure if he has a studio switching monitor. Such a monitor shows only the output of the switching system, and is not a master monitor since it will not necessarily show the picture on the program line. A studio switching monitor in addition to a master monitor would be necessary in such a set-up: this is more than most stations which have installed this equipment have been able to provide.

A second and more common method of cutting to a superimposure is as follows: One of the pictures to be superimposed is preset on the fading bus which is not in use. The other is switched onto the fading bus which is in operation and at the same instant the two fading handles are set halfway.

There is a foolproof interlock on the two fading buses which makes it impossible to preset a camera on one bus if it is already in use on the other. This interlock may help avoid a few errors, but it renders impossible a method of cutting to a superimposure described in connection with the RCA studio switching system. One cannot cut to a superimposure by punching similar buttons on both sides, setting the fading handles halfway and punching two buttons at once.

Each of the manufacturers designed the present switching equipment and production consoles two or more years ago. Each based its design on the observed production procedure at its own broadcasting studios; General Electric at WRGB in Schenectady, Dumont at WABD, and RCA at NBC. Production procedures vary from station to station and these differences between the manufacturers' testing grounds produced in large part the variation in the operating equipment just described. As new kinds of equipment are devised and tried out, a closer standardization can be expected. With the exception of patented features the future models of all three manufacturers can be expected to approach a standard design.

Color Temperature: Its Use in Color Photography

By O. E. Miller

Eastman Kodak Co., Rochester, N.Y.

Summary—Color temperature as a specification for light sources is inadequate to define any light source for color photography which departs appreciably in energy distribution from the black body. It should probably be restricted to use with tungsten incandescent lamps only. Meters devised to measure color temperature by means of measurements of the relative energy in two wavelength bands are likewise not trustworthy when applied to any but the black-body sources. A "three-point," rather than a "two-point," meter is needed for the precise control of photographic exposures. Such a meter should have sensitivity distributions that match those of the three emulsion layers of the color film.

Many important sources of light, such as the sun and the incandescent lamp, belong to a class, sometimes referred to as temperature radiators, which emit light due to high temperature. The ideal temperature radiator, from which the concept of color temperature is derived, is known as the black body, or complete radiator. It follows from the theory of the radiation from hot bodies, that a body which is a perfect absorber is also a perfect radiator. From theoretical considerations it is possible to calculate the amount of light of any wavelength that will be emitted by a black body at any given temperature. As the temperature is raised, an increased proportion of the energy is radiated at the shorter wavelengths, and the color changes from red through orange, yellow and white, to blue at a very high temperature. This series of colors forms the basis of the color temperature scale. It is important to note that many colors are not found on this scale and hence light sources having colors not matching the color of a black body cannot be expressed in color temperature. Examples are green, purple, magenta, violet, etc.

Both the color and the energy distribution of a black body are known, once the temperature is specified; hence, when applied to practical sources, color temperature can refer to either or to both of these two aspects of the source. The definition of color temperature adopted by the Optical Society of America[1] refers to the color alone

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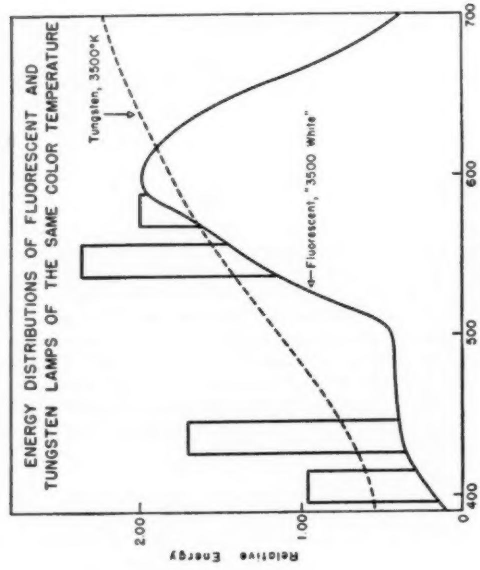

Figure 2.

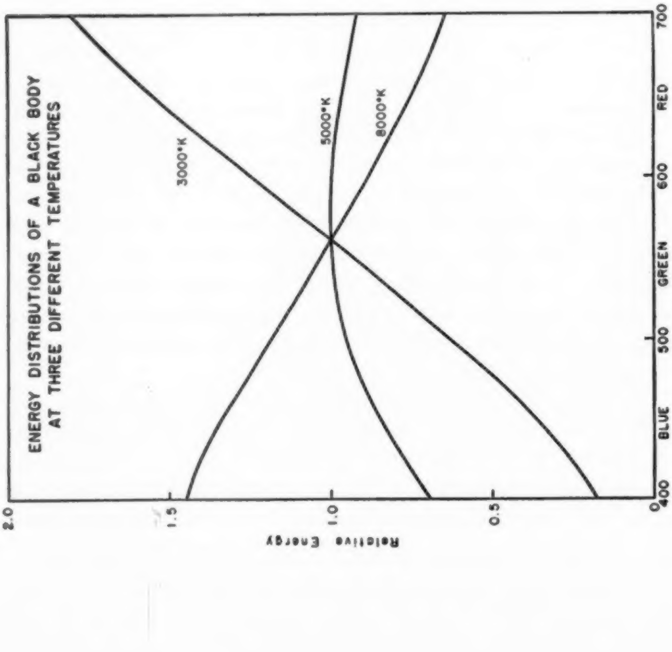

Figure 1.

and this definition has been generally accepted.[2] The color temperature of a light source may be defined as the temperature of a black body that matches the color of the source in question.

It is a property of color vision that sources of many different energy distributions may appear exactly the same color. Furthermore, it can be demonstrated easily that the suitability of a source for the illumination of colored objects is determined more by its energy distribution than by its color. Hence, unless the source has a known energy distribution, the color temperature specification is not usually sufficient to describe the most important aspect of the source. The energy distribution curves of Fig. 1 are characteristic of those of a black body. The temperatures are expressed in the absolute scale, in degrees Kelvin (°C + 273). Many familiar practical sources of light such as the tungsten incandescent lamp, not only match the color of a black body, but even have nearly the same energy distribution, although the actual temperature may differ from the color temperature. A tungsten filament, for example, may have a color temperature of 3000 K when its actual temperature is 2970 K. The candle flame is another example of a light source which closely resembles a black body both in color and in energy distribution. Such sources may be specified sufficiently well for most purposes in terms of color temperature alone because the energy distribution is known to be similar to that of the corresponding black-body source.

Many other sources, however, have energy distributions that are very different from those of a black body, although they may match the color of a black body at some temperature. An example is the fluorescent lamp. Illustrated in Fig. 2 is the energy distribution of a fluorescent lamp known to the trade as "3500 White," compared to that of a tungsten lamp operating at a color temperature of 3500 K. While these two sources in themselves have nearly the same color, the colors of familiar objects often look quite different under them. These differences in appearance are due to the differences in the energy distributions. The practical problems created by such differences in energy distribution are recognized by meat dealers, for example, who have observed the unfavorable dark red appearance of choice meat when illuminated by fluorescent lamps. Diners in restaurants also have objected to the greenish appearance of egg yolks.

If the source departs radically from the energy distribution of a black body, then a color temperature specification is of questionable

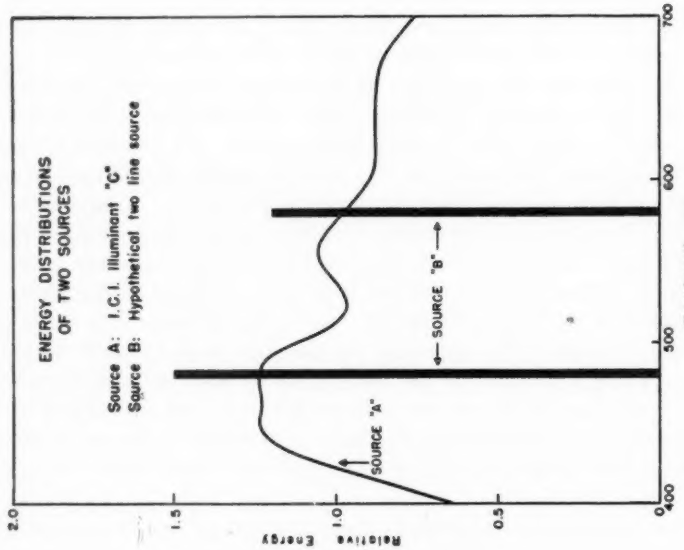

Figure 3.

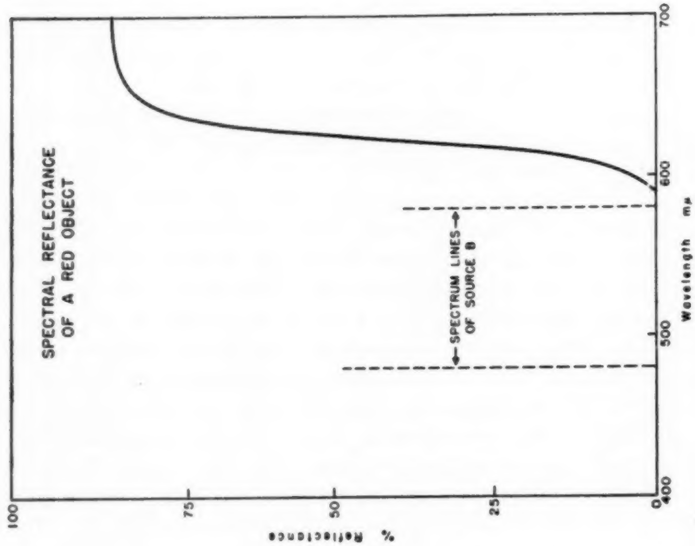

Figure 4.

value. The color temperatures of the two sources illustrated in Fig. 2 are the same; so color temperature in this case fails to distinguish between a good source and one which is much less suitable for the illumination of certain colored objects. Some authorities[3,4,5] are already giving serious consideration to the complete abandonment of color temperature as a specification of light sources, or at least restriction of the use of such specifications to tungsten incandescent lamps alone. Jones[3] suggests the use of the true temperature as an index of the spectral distribution of radiant energy from tungsten lamps. The important point to be recognized is that color temperature is a *color* specification, and as such it is inadequate to describe any but a very restricted class of artificial sources, principally tungsten lamps. It is inadequate because it fails to describe the most important aspect of the source, its energy distribution.

The inadequacy of a color specification for light sources may be further illustrated by an even more striking example of the effect of the energy distribution of an illuminant on the appearance of a colored object. While we usually consider white light to consist of a mixture of light of all the wavelengths of the visible spectrum, it is a well-known property of color vision that white also can be simulated by a mixture in the proper proportion of lights of only two, or at most, three wavelengths. Two such wavelengths are called complementary wavelengths. Consider two sources, then, with energy distributions such as those illustrated in Fig. 3. Both of these sources would look substantially white to a normal observer. They have the same color temperature. Source A is the standard I.C.I. (International Commission on Illumination) Illuminant C, and is similar to one phase of daylight; hence, objects appear in their normal colors under source A. Source B, however, contains light of only two wavelengths, one in the yellow, the other in the blue. Let us consider, now, the differences in the appearance of some typical colored objects under these two sources.

The color of an object results from the selective reflection, absorption or transmission of the light of various wavelengths falling on its surface. Thus a red object may reflect only the red wavelengths and absorb light of all the remaining wavelengths. This property of a surface may be represented by a curve such as that in Fig. 4, which shows the percent of the incident light that is reflected by the surface of a red object at each wavelength of the spectrum. When the light from any source falls on a colored surface, it gives rise to reflected

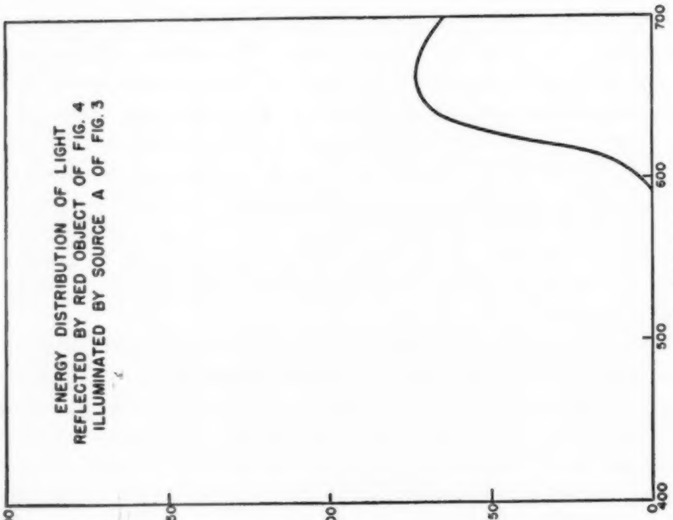

Figure 5.

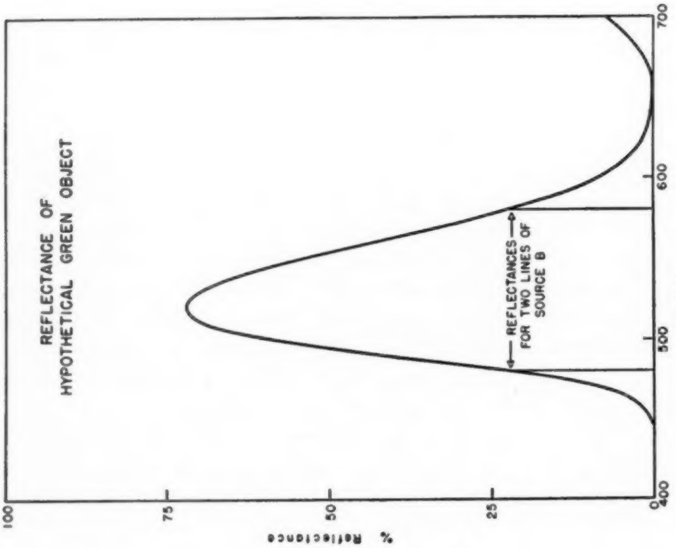

Figure 6.

light which generally has an energy distribution different from that of the source. It is the energy distribution reaching the eye from the object that defines the resulting color stimulus. This energy distribution may be obtained for the red object under source A by multiplying the ordinates of the curve in Fig. 4 by the ordinates of the energy distribution curve for source A in Fig. 3. The resulting energy distribution reaching the eye from the red object is shown in Fig. 5. Since only the red wavelengths are reflected, the object appears red. For source B, however, there is no red light from the source but only blue and yellow, both of which are absorbed by the red object, so no light at all is reflected and the red object appears black. By similar reasoning, it is possible to show that with the same source other objects may appear yellow, blue or neutral, depending on their relative reflectances for blue and yellow light. Figure 6 is the reflectance curve of a green object. Since the reflectances of this object for the two lines of source B are equal, the object appears the color of the source or neutral gray. While our example, source B, represents an improbable extreme, it differs in degree only from many practical sources. Some fluorescent lamps have a deficiency of energy in the red region which is balanced by a corresponding deficiency in the complementary wavelengths, the blue-green. Also there is an excess of energy in the yellow and green which is balanced by an excess in the complementary wavelengths, the violet. Lamp manufacturers are aware of these deficiencies and are working steadily for the improvement of commercial fluorescent lamps.

Commercial processes of three-color photography employ films having three sensitive emulsion layers with spectral sensitivities somewhat similar to the sensitivities of the color receptors of the eye. Hence color photography is almost exactly analogous to color vision in this respect. Color adaptation, by which familiar objects tend to retain the same appearance whether viewed by tungsten light or daylight, is, in the end result, analogous to the use of color correction filters with the color film so that objects photograph the same color by different light sources. And with color photography, the energy distribution of the source is just as important a factor in the appearance of objects as it is in vision.

It is customary, because of the convenience, to specify tungsten studio lamps in terms of the color temperature for which the film is balanced. Thus, Kodachrome Professional Film Type B requires a color temperature of 3200 K. Lamp manufacturers supply lamps

that will operate at approximately this color temperature when burned at their rated voltage. Since tungsten lamps change in color with age, changes in line voltage and blackening of the glass envelope, color photographers have had a real need for some means of checking the color temperature of their lamps. To supply this need, color temperature meters are now available. If voltage control is provided for in the studio, a color temperature meter offers a guide for the adjustment of the lamp voltage to obtain the proper color temperature. If the lamp voltage cannot be adjusted, the meter reading may indicate when a color correction filter is needed.

Several color temperature meters are designed to measure color temperature in terms of the ratio of the energies in two separate wavelength regions of the spectrum and are calibrated either to read color temperature directly, or to read in terms of the color filter required. It is assumed that the energy distribution is of the black-body type, and hence the readings are liable to serious error if the distribution departs seriously from that assumed. This limits the usefulness of such meters almost entirely to tungsten incandescent lamps.

Unfortunately, some of these meters may be used with daylight. But a color temperature specification of daylight is difficult, because the energy distribution of daylight departs considerably from that of a black body. This does not mean that daylight is an unsuitable source for color photography, but rather that it does not match a black body in color and therefore cannot be specified accurately in terms of color temperature. Daylight is made up of a mixture of varying proportions of sunlight and skylight. While sunlight alone, or skylight alone, are rough approximations to black-body radiation within the visible spectrum, mixtures of the two are not, since an additive mixture of the radiation from two black bodies of different temperatures will not match a black body at any temperature. Figure 7 illustrates this point by showing one mixture of the radiation from two black bodies operating at 2000 K and 20,000 K, respectively. A mixture somewhat resembling this might be encountered in late afternoon when the sun is quite red and the sky a bright blue. Also shown is the energy distribution of a black body at 3000 K. A color temperature meter based on measurements of the energies at wavelengths 520 and 690 mμ would indicate that the mixture was equivalent to the black body at 3000 K, whereas it has much more energy in the blue and red and less energy in the green than the 3000 K black body. The mixture is

quite pink and very far from matching a black body at any temperature.

In view of the departures of daylight from black-body radiation, which are neither constant nor systematic, there is some room for doubt as to the usefulness of a color temperature specification in connection with daylight, and existing color temperature meters may

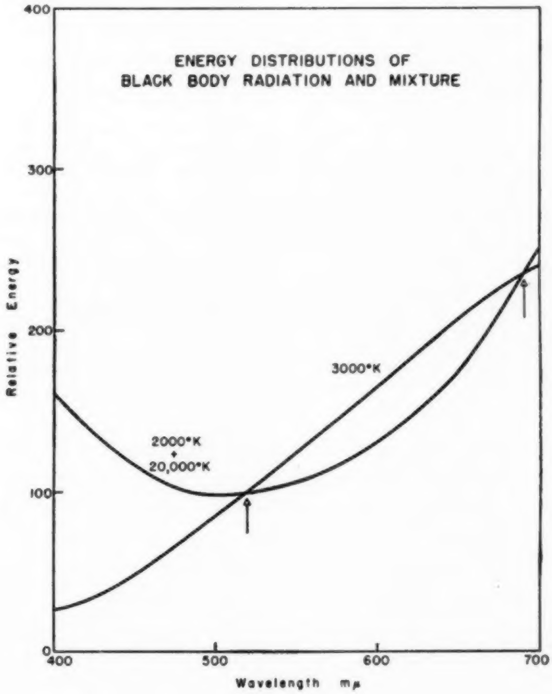

Figure 7.

give very misleading results. For many purposes satisfactory exposures can be made in daylight without any color compensation, provided exposures are avoided during the hours of early morning and late afternoon. At such times results are often unsatisfactory anyway unless the object is to record the sunset or sunrise effect itself.

In some applications of color photography precise control of daylight exposures may require that occasional filter corrections be made

for the normal variations in the quality of daylight. Since it is the relative exposure of the red, green and blue records in the film that determines the color balance of a picture, a meter is needed which is capable of measuring the amounts of energy in the red, green and blue regions of the spectrum. Ideally, such a meter would have three sensitive elements with spectral sensitivities like those of the three emulsion layers of the color film. The three readings could then be interpreted in terms of the exact filter corrections needed to give a balanced exposure. For such a meter to be useful a minimum of computation should be required to translate the meter readings into filter corrections.

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An Experimental 35-Mm Multilayer Stripping Negative Film

By JOHN G. CAPSTAFF
EASTMAN KODAK CO., ROCHESTER, N.Y.

Summary—The so-called "three-strip" method is generally considered to give the best results when taking professional color motion pictures. An objection to this method is that it requires the use of a special camera fitted with a beam-splitter prism. This paper describes work that led to the development of a single multilayer negative film which can be used in any standard motion picture camera. After exposure and before development, the two upper layers are wet-stripped separately onto special transfer supports. Thus the single support of the multilayer film bears three color-sensitive emulsions in the following order: a red-sensitive layer next to the support, an intermediate green-sensitive layer, and an upper blue-sensitive layer. The red- and green-sensitive layers, and the green- and blue-sensitive layers are each separated by interlayers which facilitate stripping of the two upper layers. The film has an over-all thickness about the same as standard motion picture negative film. Its speed is such that good negatives of an open landscape can be exposed at $f/8$ or even $f/11$. An experimental stripping machine is described which accurately registers the perforations of the two stripped layers with those of the original film on which remains the red-sensitive layer.

IT IS GENERALLY ACKNOWLEDGED in the motion picture industry that the method of taking professional color motion pictures that has given the best all-around results is the so-called "three-strip" method. The separate films, after exposure, are developed in a regular negative developing machine, resulting in three excellent original tricolor negatives. An objection to this method is that a specially designed beam-splitting camera must be used. The question came to mind: Would it be possible and practical to design a single film which could be used in any standard motion picture camera, with regular optics, and which, after processing, would give a set of original tricolor negatives of quality comparable to those made by the three-strip method? One answer seemed to be a stripping film.

Late in 1940 experiments were started on the design of such a film on which a single support would bear three color-sensitive emulsions, the first layer next to the support being red-sensitive, the next layer green-sensitive, and the top emulsion blue-sensitive. Between

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the red-sensitive layer and the green-sensitive layer would be a special interlayer having the property of adhering to the emulsions when dry but readily coming apart when wetted in water. It was thought that hydrolyzed cellulose acetate of a suitable acetyl content would probably meet these requirements. An interlayer of the same type would separate the green-sensitive emulsion and the blue-sensitive emulsion layers. Because of the fact that the green-sensitive layer and the

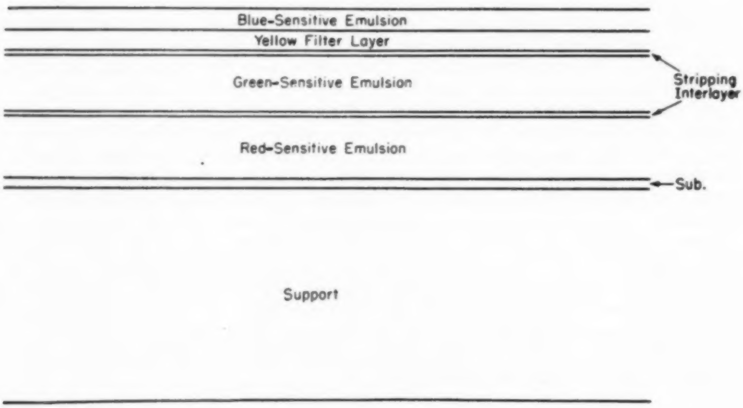


Fig. 1. Cross section of multilayer stripping film showing relative position of emulsion layers, filter layer and stripping interlayers.

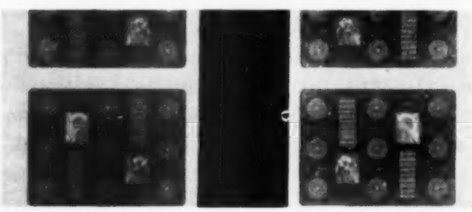


Fig. 2. Sample negatives obtained with early experiments.

red-sensitive layer are also sensitive to blue light, it would be necessary to interpose a yellow filter layer between the blue emulsion and the green emulsion (Fig. 1).

In the first experiments, a two-layer film only was attempted, since obviously if a single stripping operation could not be done successfully, satisfactorily stripping the more complicated triple layer would be highly improbable.

On February 6, 1941, exposures of a resolving-power chart were made in a Mitchell camera on such a two-layer film. The stripping was done before development on a simple machine on which the strippable emulsion layer was transferred onto a special transfer film bearing a suitable substratum. There was no pretense at maintaining registry between the two images, which, of course, must be accomplished for motion picture making. Figure 2 shows actual samples of these first negatives.

The technique of stripping was simple. The two-layer film was wetted in plain water, temperature approximately 70 F, for about 10 sec, and while under water was brought in contact with the transfer film; then the two films were rolled into intimate contact between two rubber-covered rollers. The "sandwich" was then allowed to remain for about a minute in order that the emulsion layer about to be stripped could bond to the transfer film. The actual stripping operation was performed over two rollers. After drying the film, development was performed in the conventional way.

About this time a blue-sensitive emulsion, bearing on its surface a yellow filter layer, was coated on a separate film. This made bipack experiments possible. Quite a bit of this bipack work was done on 4 x 5 in. and 5 x 7 in. sheet film, the bipack being exposed in a camera having a sheet of plain glass in the film holder. Some useful experiments were carried out in this way insofar as the emulsion properties were concerned, but the scheme was soon abandoned as far as serious picture making might go, because of the many defects in the negatives, such as Newton rings, dirt and halation.

Soon after this, a crude 35-mm machine was assembled which permitted stripping some film in which the perforations of the two-layer film were held in precise registry with the transfer film during the bonding period.

Color prints from these two negatives were made on a contact registering printer. The prints were found to be in good registry and no signs of distortion of the stripped emulsion layer were evident.

After this encouragement, a three-color multilayer film was attempted, but it was not until July 29, 1942, that a successful three-color coating was available for camera tests. The over-all thickness of this multilayer film was approximately the same as a black-and-white motion picture negative film. The sensitometric characteristics were excellent, all three emulsion layers having an exposure lati-

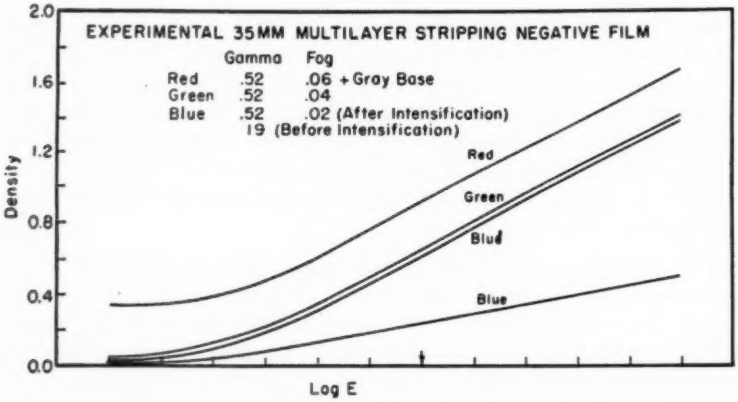


Fig. 3. Typical sensitometric curves for the three layers of multilayer stripping film.

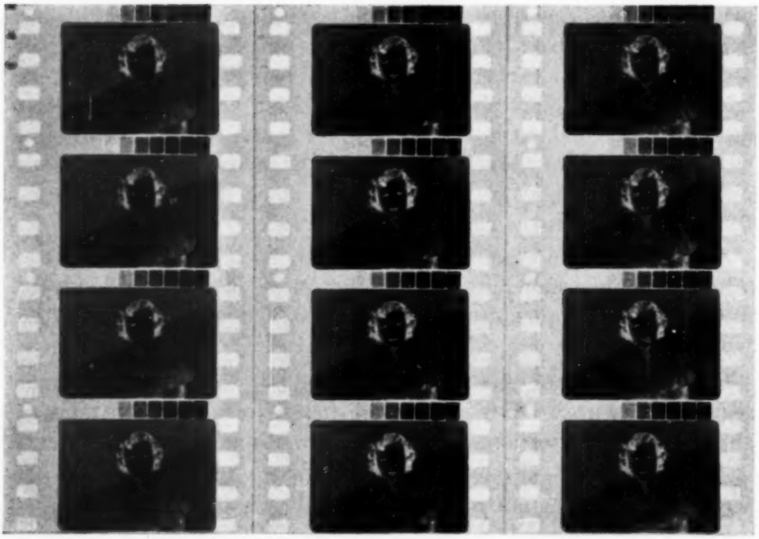


Fig. 4. A typical set of multilayer stripping film negatives.

tude comparable to that of regular negative material (Fig. 3). The speed was such that good negatives of an open landscape could be made at $f/8$ or even $f/11$. The keeping properties of the emulsion layers equaled those of regular black-and-white emulsions. Because of the thinness of the three emulsion layers, the gammas were on the low side, the red- and green-sensitive layers giving a gamma of about 0.55, and the blue-sensitive layer still lower, being approximately

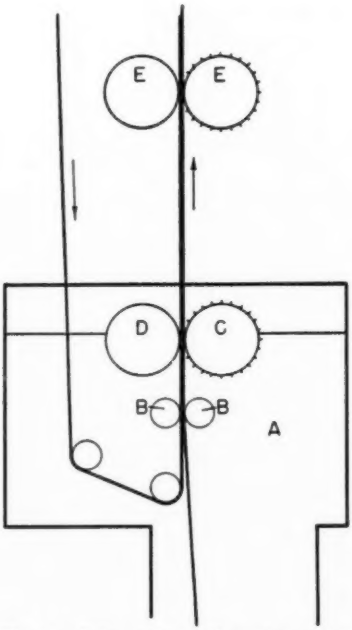


Fig. 5. Schematic section of machine showing rolldown registering station.

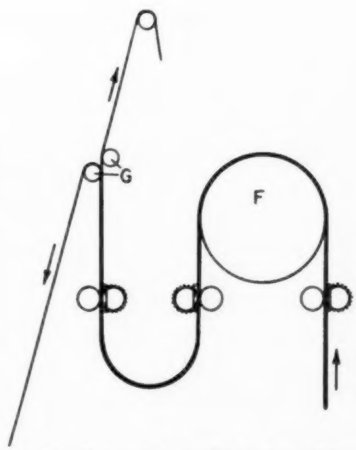


Fig. 6. Schematic section of machine showing stripping station.

0.30. The blue-sensitive layer was purposely made with a low silver halide density in order to interfere as little as possible with the resolving power of the two underlying emulsion layers. For most printing processes this necessitated either intensifying the blue negative or making a "dupe" having the desired over-all gamma.

When working out a motion picture film, it was considered important to succeed in stripping prior to development in order to avoid defects arising from depth development. As is well known to those

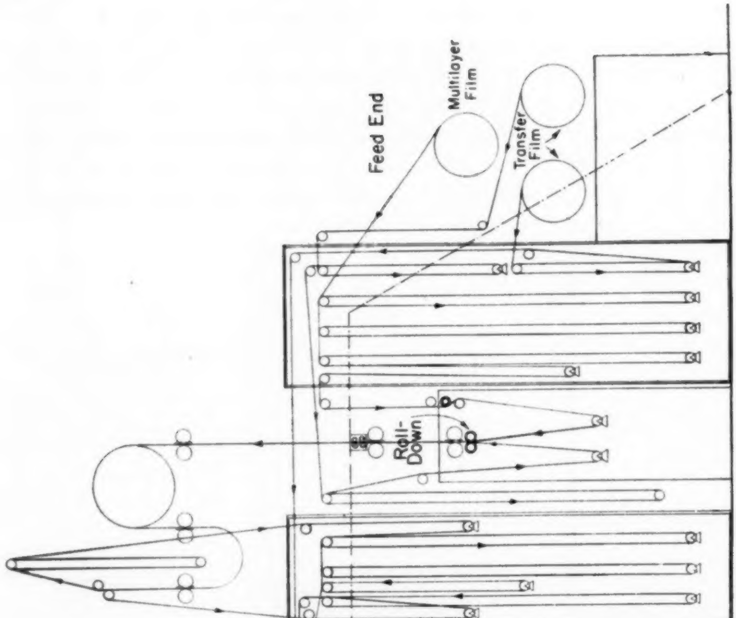


Fig. 7. Kodak multilayer film-stripping machine.

working with material coated in several layers, these defects can be quite serious. The defects are caused mainly by the reaction products in the lower layers diffusing to the upper layers. Another advantage in stripping before processing is that a certain measure of gamma control is possible by regulating the amount of development in the usual way.

Good progress was being made both in the manufacturing end and in the processing end. Many thousand feet of tricolor film were stripped, developed and printed, although the process could not yet be regarded as ready for the market. The photographic quality of the negatives was of a high order of excellence (Fig. 4) and obviously could be used in any of the known color printing processes.

During the war years, work on the preparation of coatings was practically brought to a standstill, though worth-while efforts were continued in other directions, particularly in the design of a registering-stripping machine. After two or three machine designs had been tested and rejected, the basic principles on which a practical machine could be built were established and practical experimental work was done as circumstances permitted, ending in the construction of a machine, the essential parts of which are shown schematically in Fig. 5.

In the figure, *A* is a tank of 70 F water in which the multilayer stripping film and the transfer film are wetted for approximately 10 sec. The two films meet at the rubber-covered wringer rollers, *B*, where they are rolled into intimate contact. Four inches farther on, the perforations of the two films are brought into accurate registry by means of a specially designed sprocket, *C*, and a socket roller, *D*. The sprocket roller, *C*, is positively driven at the film speed of 30 fpm. Since the perforation pitches on any two films are never exactly alike, it is necessary on the machine to keep the shorter-pitched film stretched to match the pitch of the longer one during at least part of the bonding time. This is accomplished by means of two other sprocket-socket roller assemblies, one of which is indicated in *E*. These two sprockets are friction clutch-driven and have an overdrive of approximately 5%, thus maintaining the required tension. The distance between the registering sprocket and the first overdriven sprocket is 18 in., and it is 48 in. between the first overdriven and the second overdriven sprocket.

By the time the film arrives at the second overdriven member, the adhesion between the emulsion and the transfer film is such that the

Fig. 8. Hand-stripping of multilayer film.

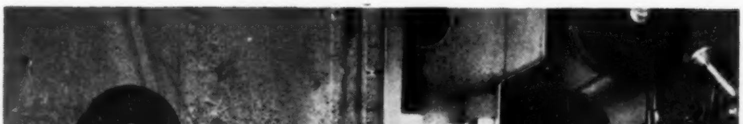


Fig. 9. Close-up of stripping machine showing rolldown registering station.

films can continue on their path without being under tension, although the bonding is not firm enough for stripping.

In Fig. 6 the "sandwich" next is seen passing over a sheave, *F*, then down into a loop, and finally up to the two simple stripping rollers, *G*. After parting company, the two films pass through a drying cabinet of conventional type from which the stripped emulsion passes on to a regular take-up at the end of the machine (Fig. 7), while the red-plus-green multilayer film, when dried, continues on to a second wetting, rolldown, registering station, and is stripped in the same manner as the blue-emulsion layer. The red-sensitive emulsion remains on the original support. After these two films are dried in a second drying cabinet, they are also taken up at the end of the machine. Development is done on another machine.

In Fig. 8 a small piece of film is shown being stripped by hand. Figure 9 is a close-up photograph showing in detail the important rolldown registering station on the stripping machine that was sketched in Fig. 5. In the photograph (Fig. 9) is seen a straight film track. It is important that the films, when registered, move on through the machine in a straight line until the adhesion is sufficient to prevent slippage occurring between the two films. As previously mentioned, this state is reached immediately after the film has reached the second overdriven sprocket. The track serves to maintain the film in the required straight path and also acts as a means of stripping the films from the registering sprocket. The purpose of many of the other details in the photograph will be easily understood by film-processing engineers.

NOTE: At the conclusion of the paper, a short motion picture was shown which demonstrated the method of stripping the multilayer film, first by hand using small pieces, then by the registering and stripping machine with long lengths of film.

Printing Equipment For Ansco Color Film

By F. P. Herrnfeld

Ansco, Hollywood, Calif.

Summary—**The Scenetester takes the place of a cinex machine in manufacturing Ansco Color prints. Its primary function is to make it possible for the timer to select for a given color original or dupe the proper color correction filters and printing density. The Scenetester must match the printer or printers it is teamed with for absolute light output, color balance, exposure time and light changes. This paper describes a Bell & Howell Model D printer modified for color printing and a Scenetester which was made for darkroom operation. The Scenetester prints 16 frames simultaneously through 16 different color correction filters and was designed to work with modified Bell & Howell Model D printers.**

The printer modification consists of adding a new lamphouse, and the installation of an automatic filter changer (Fig. 1). The filter changer works on the principle of a slide projector. The individual filter packs are mounted in semitransparent filter holders and are stacked in the proper sequence in a feed magazine. The contactor originally operating the semiautomatic light-change mechanism and light-card indexer is employed in this modification to activate also the solenoid of the filter changer. For every light change, a filter slide change automatically takes place, whether or not a filter change is necessary.

Figure 2 shows the optical system employed. The light source is a standard 750-w, 120-v, T-12 pre-focus projection-type lamp. In operation this lamp voltage is adjusted to approximately 95 v, giving it a color temperature of about 2900 K (degrees Kelvin). This low color temperature increases the life from the rated 50 hr to about 1600 hr.

A condenser focuses the filament of the lamp in an objective lens. The objective lens in turn focuses a plane in the condenser on the ground glass of the Bell & Howell printer, located at the aperture of the light-change mechanism.

A fire shutter is located between the lamp and the condenser. A

Presented: October 11, 1949, at the SMPE Convention in Hollywood.

filter holder is located on the other side of the condenser in the least intense part of the light beam. This filter holder accommodates the emulsion correction filters, an Aklo heat absorbing glass, and an Ansco UV-16 printing filter. Part of the forced air for cooling the printing light is directed over this filter pack.

SCENETESTER

The basic elements of the Scenetester are a light source, optical system, a calibrated light-change mechanism, a curved platen for 16 color correction filters, means for holding the camera film over the platen and a printing film stock carriage. The lamp receives its power directly from an a-c line through a voltage regulating transformer. The color temperature of the light is set by a variable transformer (variac), with an a-c voltmeter connected directly across the terminals of the lamp. Forced air ventilation is provided for the lamp and the emulsion color correction filters to permit continuous operation of the lamp.

The optical system of the instrument is similar to that of the printer modification, particularly the light source and lens system (see Fig. 3). A rotating mirror, mounted on a shaft driven by a synchronous motor and centered with the axis of the lens system, deflects the light beam from the objective lens through an angle of 90°, and causes it to scan the curved printing platen. The lengthwise centerline of the platen aperture is aligned with the axis of the rotating beam.

The mirror is fastened inside a tunnel to keep stray light from falling onto the film. An adjustable aperture is located on the end of the tunnel within $\frac{1}{4}$ in. of the camera stock being tested. This aperture may be adjusted to give any exposure between $\frac{1}{10}$ and $\frac{1}{50}$ sec to match the exposure time of the printer with which it is teamed. With a Bell & Howell printer running at 60 ft per min, the exposure time is set for $\frac{1}{48}$ sec.

The length of the platen opening is slightly over 12 in., accommodating 16 single-frame color correction filter combinations. The radius of the platen is such that the camera and printing films are engaged over an arc of 140°.

Two exposure platens were made for each instrument. One of the platens was furnished with the color correction filter packs shown beside Fig. 4, each filter combination covering one 35-mm frame. Such a platen is now being used for making scene tests.

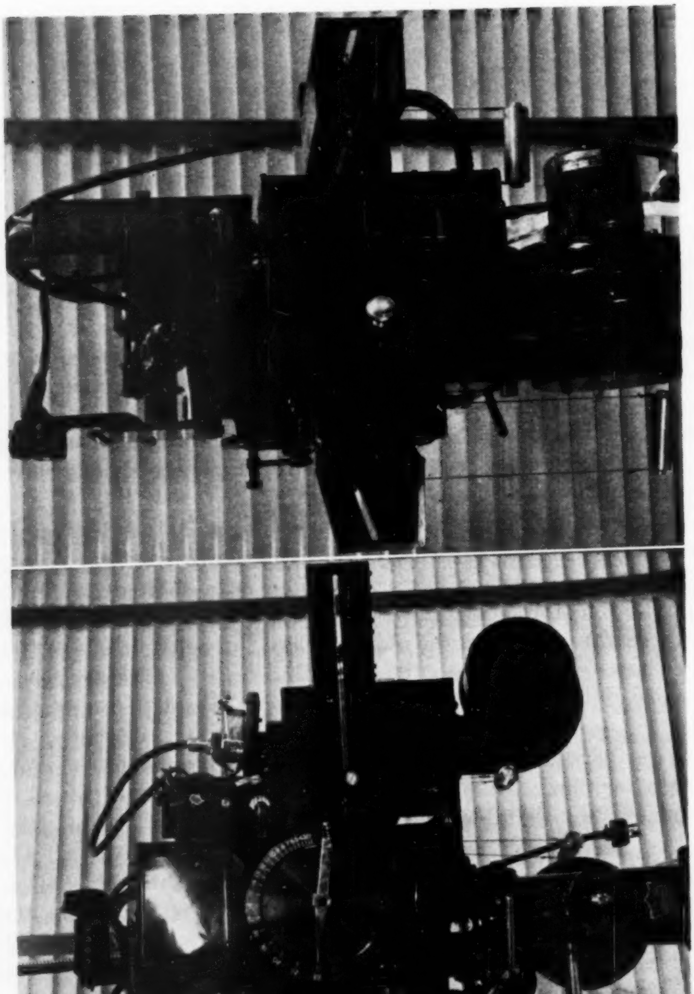


Figure 1.

Color correction filters come in three series:

1. The yellow series (20), which absorbs blue and transmits green and red.

2. The magenta series (30), which absorbs green and transmits blue and red.

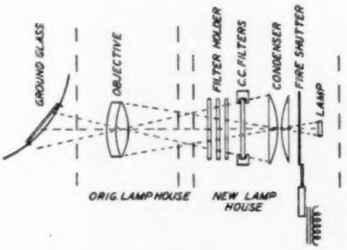


Fig. 2. Modified Bell & Howell Model D printer optical scheme.

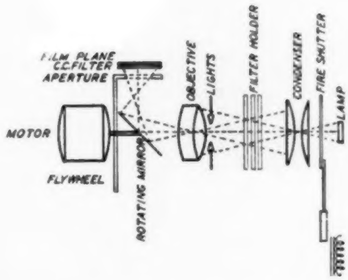


Fig. 3. Scenetester scheme.

Frame	*Color Filter*	*Frame*	*Color Filter*
1	None	*11*	1 – 24
2	1 – 24		1 – 25
3	1 – 24		1 – 34
	1 – 34	*12*	1 – 24
4	1 – 34		1 – 25
5	1 – 35		1 – 35
6	1 – 35	*13*	1 – 24
	1 – 24		1 – 25
7	1 – 35		1 – 34
	1 – 25		1 – 35
8	1 – 34	*14*	1 – 25
	1 – 25		1 – 34
9	1 – 25		1 – 35
10	1 – 24	*15*	1 – 24
	1 – 25		1 – 34
			1 – 35
		16	1 – 34
			1 – 35

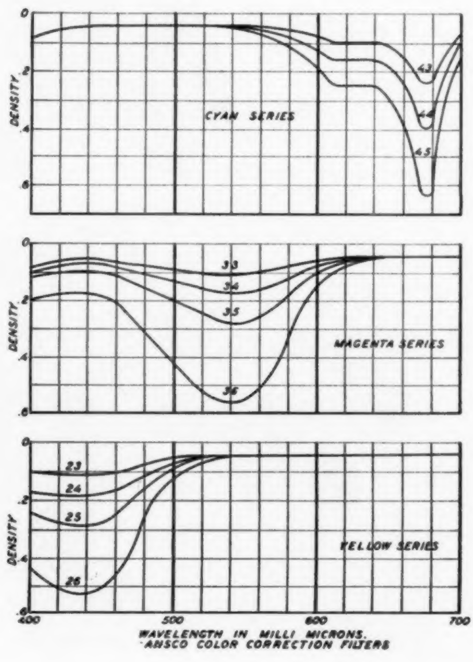


Fig. 4. Ansco color correction filters.

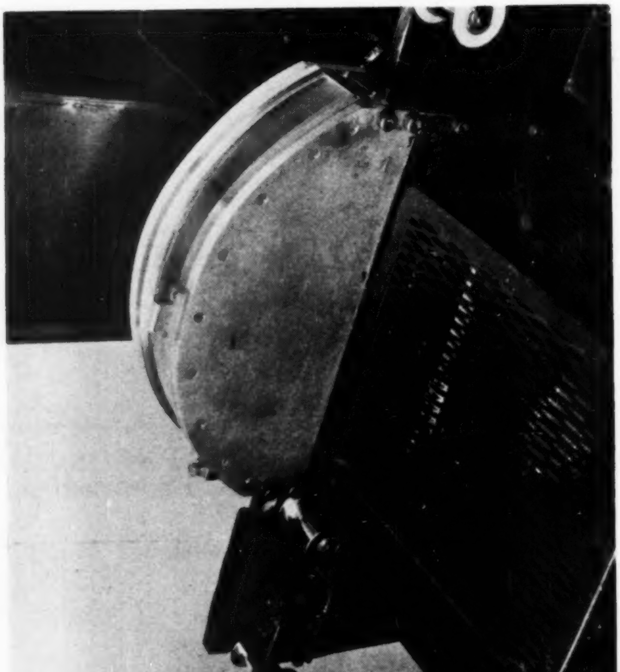


Figure 5.

3. The cyan series (40), which absorbs the red and transmits blue and green.

The numbering system is arranged so that 4 (*i.e.*, 24, 34 and 44) will give a reduction of one-half stop of light in printing value for Ansco Color printing films in the desired band. Numbers 3 denote ¼, 5 denotes 1, and 6 denotes 2 stops.

The curves in Fig. 4 show the insertion losses of these filters plotted in density versus wavelength.

From these curves it is evident that the least number of filters will give highest efficiency. For instance, one 24 will give ½ stop correction in the blue end with only 15% insertion loss in the rest of the spectrum. Two 23's will give also ½ stop correction but will increase the insertion loss in the rest of the spectrum to about 27½%. With the amount of light used in printing color film this becomes a factor to be reckoned with. Filters of all three series should never be put into one pack because, for instance, one 24, one 34 and one 44 would act the same as putting a neutral density of approximately 0.15 into the light beam; however, one 26, one 36 and one 45 can be replaced by one 25 and one 35 with one stop more light available to the film.

The other platen was furnished with two methyl methacrylate resin (Lucite) window leaves 1/16 in. thick. Sufficient room was allowed in the construction of the platen to place a neutral dye or silver step wedge between the two pieces of plastic. This platen is used to make intensity scale sensitometric strips.

The scene test and sensitometric platens are interchangeable without the use of tools during darkroom operation.

A filter holder for the emulsion correction filters, Aklo glass, and related items, is provided as in the printer. It is accessible during darkroom operation. Filters can be changed while the printing light is burning without fogging the raw stock.

The light-change aperture is located between the elements of the objective lens. It has 21 discrete steps, being separately adjustable to give a light change from 1/12- to ⅕-stop per step. The total range for the 21 steps can be adjusted to give from 1¾ to 4⅕ stops variation from light 1 to 21. To assure that the flatness of field at the film is not altered when changing the light intensity, a ground glass was placed between the lamp and the condenser. The ground glass also makes placement of the filament of the lamp less critical. The illumination across the film width is uniform within ±2%, while the illumi-

nation along the platen length is within $\pm 3\%$. This uniformity was verified by film exposures.

The camera film to be tested is held between two rewinds. It is threaded through a viewing box, over the film platen and to a take-up. The viewing box is located to the left of the film platen, with light shields to permit darkroom operation. The primary function of the viewing box is to frame the camera original with the color correction filters in the platen. Sprockets, rollers and weighted rollers are arranged in such a manner as to allow easy threading in the darkroom with a minimum of danger to the camera film.

The printing film is mounted on a manually operated carriage which accommodates 400 ft of Ansco Color printing film raw stock (see Fig. 5). The spindles holding the film are made to take either negative or positive plastic film cores. The film is fed from the unexposed roll over a film sprocket, under a curved pressure plate, over another film sprocket, and onto the take-up spool. The two film sprockets are coupled by a chain-and-sprocket arrangement to assure a constant loop under the pressure plate. When the carriage is moved down into the exposure position, *i.e.*, at the point of contact between camera and printing film, a microswitch starts the exposure cycle. This cycle is completely automatic and has safety features preventing the exposure of less than a full platen, as well as double exposures. A contactor in series with the fire shutter also prevents accidental fogging of the film due to too early release of the carriage.

As the camera and the printing film are engaged over an arc, it is necessary to move the printing film vertically away from the camera film until the loop of printing film has cleared the camera film by at least ½ in. before the raw stock is advanced. Only after all physical contact between camera and printing film has ceased, will the automatic transfer of the printing film start. At each upward stroke of the raw stock carriage, at least 20 frames of printing film are transported onto the take-up spool. At the completion of the upward stroke, a contactor automatically resets the instrument for the next exposure cycle. If the upward stroke is not completed the fire shutter will not open upon contact of the printing and camera film.

Correlation Between Printer and Scenetester

In adjusting the Scenetester for the proper light and color temperature to match the color printer, a color temperature meter of the comparative type is an invaluable aid (see Fig. 6). A meter built for this

particular purpose utilizes a Weston Model 856 photovoltaic cell and a 200 microammeter having resistance of approximately 12 ohms. With this low resistance the meter reading will be practically linear with change in light intensity. Approximately 75 ft-c will give basically full scale deflection.

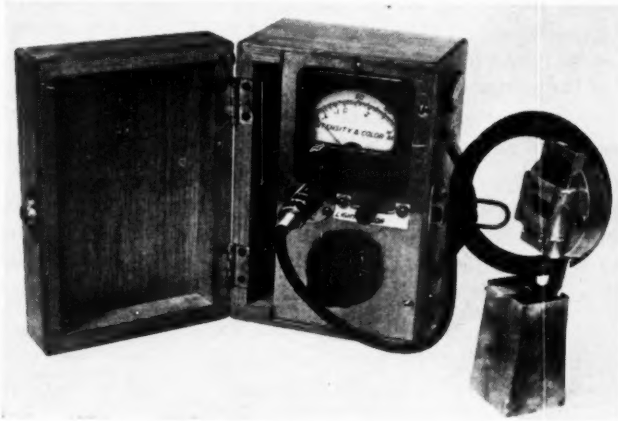


Fig. 6. Color temperature meter.

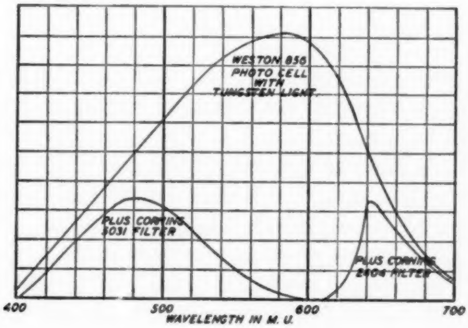
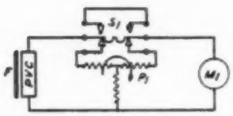


Fig. 7. Relative sensitivity of color meter and filters.

A neutral density and two filters are used in conjunction with the meter. The first is a fine grain silver density to reduce the light input to the photovoltaic cell by a factor of 5. The second filter is a blue-green Corning glass #5031, 5 mm thick. The third is a red Corning glass #2404, 2 mm thick. The transmission characteristics of the two color filters are shown in Fig. 7.

The filters are mounted in a slide holder which fits the gate casting of a Bell & Howell printer and which is provided with an adapter for use with the Scenetester. The aperture of the meter is made to take the full light output from either the color printer or the Scenetester. This slide holder has four positions. In the first position the light reaches the photovoltaic cell directly, allowing the meter to give a readable deflection at the lowest printer point. In the second position the opening is covered with the silver density reducing the sensitivity of the meter from 75 to about 375 ft-c. In the third position the opening is covered with the blue-green filter. With the slide in this and the next positions, a T-pad is switched into the electric circuit of the meter. This pad is for the purpose of adjusting the meter to 100%, the reference point for color temperature measurement. The fourth opening is covered with the red filter. The difference in reading between the two filters is the color temperature indication. The electric circuit of this color and light meter is shown in Fig. 8.



F_A Clear
F_B 0.70 neutral density
F_C Corning 2404, 2-mm filter
F_D Corning 5031, 5-mm filter
M_1 Weston 200 U.A.D.C. meter

PVC Weston 856 cell
P_1 15-ohm T-pad
S_1 D.P.D.T. switch

Fig. 8. Color meter scheme.

All measurements on the color printer and the Scenetester must be made with the heat absorbing glass and the Ansco UV-16 printing filter in place.

In practice the lamp rheostat of the color printer is adjusted until the light meter reads between 240 and 350 ft-c with the printer set to picture aperture and maximum light. After this adjustment the pad is set to give a meter reading of 100% with the blue-green filter. Then the red reading is noted. The meter should read about 80% in reference to the blue-green. If the red reading is higher than 80%, the lamp voltage is increased and the light output decreased by inserting some neutral densities such as a fine mesh screen, a ground glass, or for smaller changes, clear glass, into the optical system of the printer. If the red reading is lower than 80%, the lamp voltage should be lowered.

Measurements on the Scenetester are inverted. With a heat absorbing glass and an Ansco UV-16 filter in place, the color tempera-

ture is adjusted first and then the necessary changes are made to obtain the same light output as that of the color printer.

All measurements made with the light meter should be considered preliminary. The light-change mechanism should not be calibrated with the meter. The final check at about every third printer light must be made photographically. For this a test loop is made. The picture of the test loop should consist of a neutral gray scale. Each gray patch should be large enough to be measured with a color densitometer. This loop should then be printed on the printer and Scenetester every third light. From this test the light-change mechanism of the Scenetester should get its final adjustment. One or two reprints may be necessary before a complete agreement between printer and Scenetester is reached.

Conclusion

Two of the Scenetesters have been completed and have been in continuous use since they were finished, one for a period of over two years. Both of these units are teamed with modified Bell & Howell Model D printers. Thus far they have performed well with very little maintenance. They are checked on a daily routine basis for intensity and color temperature with the color meter.

16-Mm Film Color Compensation

By O. K. KENDALL

National Film Board, Ottawa, Canada

Summary—Second generation color duplicates on 16-mm film are noted for problems of contrast and color fidelity. These deficiencies have been responsible for the widespread practice of printing from the original. Some experimental techniques and devices for the printing of special key* intermediates which tend to counteract these faults are explained.

During 1948, the greater part of 16-mm color release printing at the National Film Board of Canada was on Kodachrome duplicating stock printed from originals. Some productions were printed from masters, but nearly all such second generation material far exceeds the acceptable limits of contrast gain. Even duplicates printed from the original are seldom ideal in this regard.

The nature of documentary film shooting makes it impossible to assume that a given original is a standard to which all duplicates should closely correspond. Because of the quasi "candid camera" approach and the almost inevitable lighting difficulties, many scenes which are later cut together display a wide range of exposure and color deviations. To include all the necessary color and exposure corrections when release printing from such originals would be likely to involve too many operations to prove economical.

This report concerns an investigation into the possibilities of including color and exposure compensation plus counteracting measures against second generation contrasts in special 16-mm key film intermediates. Where relatively few such printing intermediates are required, it should not prove uneconomical to employ step printing, scene-to-scene color corrections, masking techniques and other custom-job methods. To this end, an early model 16-mm Depue step printer was rebuilt to provide independent timing for each color layer of the duplicating stock to be printed. Exact registration facilities for masking operations were added.

Various other auxiliaries were necessary. Timing viewer boxes were equipped with 3500 K (degrees Kelvin) light as an alternative to

* Throughout this report, "key" films refer to intermediates made by the methods to be outlined.

Presented: April 8, 1949, at the SMPE Convention in New York.

the conventional yellow light source. Color filters peaked at the wavelengths used in the tricolor printer were fitted to a Western Electric densitometer for color timing tests. A wafer-thin selenium cell probe, connected to a 50-microampere meter, provided the basic correlation of the printing exposure in each primary color.

Before describing the tricolor printer, it is desirable to outline some of the corrections that it is believed a key film should possess for release printing service.

1. The key film should release print on one light.
2. The general color-casts of significant images should be maintained on a scene-to-scene basis.
3. The deviations in the relative transmissions of significant hues which occur in both first and second generation duplicates should receive a combined compensation in the key film.
4. The key film should exhibit reduced chromaticity if a hue shift in a high chromaticity color is inevitable.
5. A chromaticity increase should be available for scenes that were overexposed in the original.
6. Underexposed and shadow areas require sufficient relative density reduction in the key film to expose correctly the release print.
7. The general gray gamma of the key film should counteract the gamma gain of the release print to bring about a match with the contrast of the original.
8. The resolution of the key film images should not be materially lower than that of the original.

Other complementary parts of the program call for integration with the black-and-white standards in routine laboratory use. The background information for color timing judgment was based on printer loop tests. Additional color printing data and the terminology used have been extensively treated by Miller,[1] Offenhauser,[2] Hanson and Richey,[3] and Yule.[4]

DESIGN OF THE EXPERIMENTAL TRICOLOR PRINTER

The design objectives of the experimental tricolor printer hinge on the provision of facilities to effect a maximum of the desirabilities for key films as outlined above. The step printer selected for modification provided the initial film handling and printing-gate facilities. The lamp-house shutter, lift cams, worm drives, master clutch and the sprockets were left unmodified. Extensive modifications were neces-

sary for the handling of color masks concurrently with the original and the raw stock. Independently adjustable clutch-drives power the three take-up rolls. All sprocket guide-rollers and other film pressure-plates are lightly spring loaded to prevent sprocket damage should any of the three films become misaligned. The alternating-current motor drive system was changed to a molded V-belt drive for greater speed constancy. The original drop-board of the pin-insertion type was discarded for a newer Depue slide-bar type.

In addition to the normal step-printing action, registration pilot

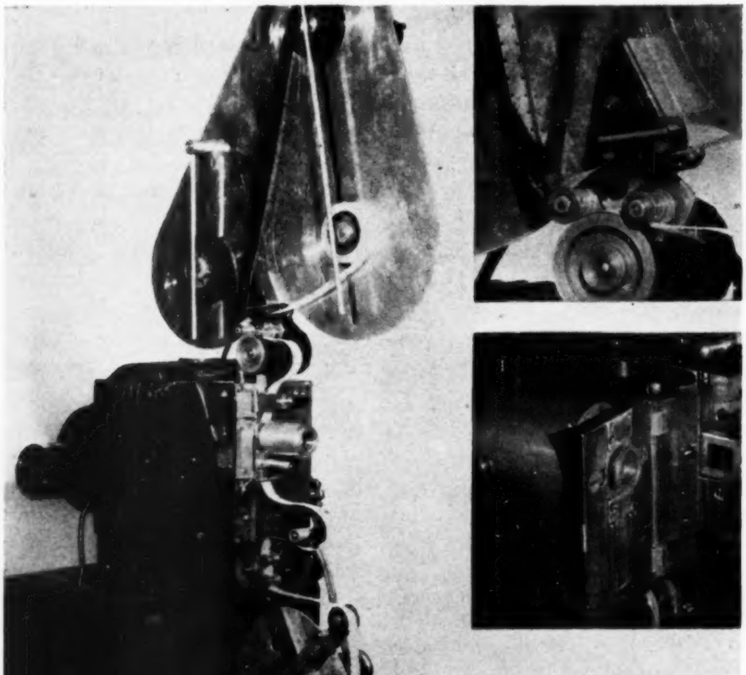


Fig. 1. General view of printer. Top insert shows shadow-flasher with raw stock route, while the "original" film (center) feeds down back-to-back to the notched masking roll at the rear. Lower insert shows view of pressure-platen and projecting registration pins. The cam-operated pins shown on each side of the printing aperture lift the registration pins and the platen in sequence when the gate is shut.

pins which span four sprocket holes were designed as part of the printer gate and viewer assembly. The pins were attached inside the viewer barrel to a spring-loaded slide-cylinder. A methyl methacrylate pressure-platen, separately spring-loaded, extends from the slide-cylinder. The platen was made slightly convex to improve the printing contact of the films at the center of the frame. Cam-operated lift-pins push the complete slide-cylinder assembly clear of the films during the pull-down operation (Fig. 1). The nonrigid pilot-pin design provides for registration between the various films which are separately aligned to the printer gate by an edge guide rail.

The original lamp house was stripped and a bakelite platform mounted in it about an inch below the printer-gate barrel. A triangular arrangement (Figs. 2 and 3) of lamp sockets is grouped on the bakelite. Ductile copper brackets extend behind each socket to form positionable supports for three concave mirrors. The mirrors were turned from solid duralumin and have a 2-in. radius of curvature. The light sources are three 16-v, 21-cp tail-light bulbs. Spring holders for glass-protected Wratten filters are provided in front of each lamp. The light beams from the two side lamp-and-mirror combinations are redirected toward the printing aperture by two flat rear-surfaced mirrors mounted in adjustable holders. Completing the lamp-house arrangements is a countersunk door on which is mounted a centrifugal fan. The air blast effectively cools the Wratten filters and the trilamp assembly, etc., and is exhausted through the bottom of the lamp house and over the timing resistance banks (Fig. 3).

It will be apparent that no provision for optical accuracy is present in these lamp arrangements. A very random direction and distribution of approximately 40 lm of tricolor light reaches the printing aperture entrance. The design postulates a light-integrating unit which is fitted in the printer-gate barrel to provide a uniform admixture of tricolor light at the film printing plane. The light-integrating unit is a parallelepipedon structure which is silvered externally on four sides. The general schematic design is shown in Fig. 2. The unit was constructed from $\frac{1}{16}$-in. sheet methyl methacrylate and sealed against dust. The total light transmission efficiency measured 75%. When visually observed through the printer gate, the unit presents a series of shifting color-casts due to the lenticular surfaces of its diffusion plates. However, regardless of the degree of irregularity in color intensity presented at the prism end of the unit, no fringing or measurable color deviations appear across a test frame when film is printed.

The arrangements for tricolor timing were designed for a minimum of change to the existing printing practices. The Depue drop-board solenoid gear was modified to drop the contact unit in steps of three at a time. Two additional contact brushes were added to make a triple contacting drop unit. The 22 riser-bars of the drop-board are connected by multiple cable and plug to three banks of adjustable tapped resistors located in the subcompartment on the printer (Fig. 3).

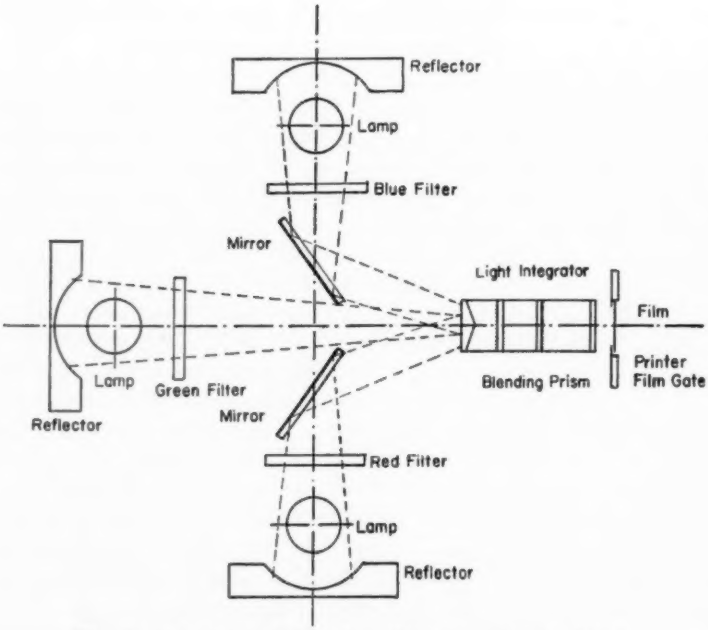


Fig. 2. Arrangement of the lamp-house components shown through the open door in Fig. 3.

Three heavy-duty rheostats provide over-all tricolor balance for top light adjustments.

The regular 22 printer lights per bar of the drop-board are divided into groups of seven. Each timing slide-bar can serve duty on any of the three colors. For convenience, sets of three consecutive slide-bars were assigned for the timing of red, green and blue, descending in that order. The timing card, as supplied to the operator, was also coded in triplets but no change to conventional operator practice is

required for the setup of the slide-bars on the board. The light changes are initiated by regular edge notches which are applied to the masking and timing film roll.

An extra triple-pole switch is located on the printer. It serves to connect the three lowest printer lights to the line regardless of the setting on the drop-board. Four of the riser bars on the board are not connected and are accordingly coded as zeros. This design provides for a minimum or "base light" connection so that all lamps may

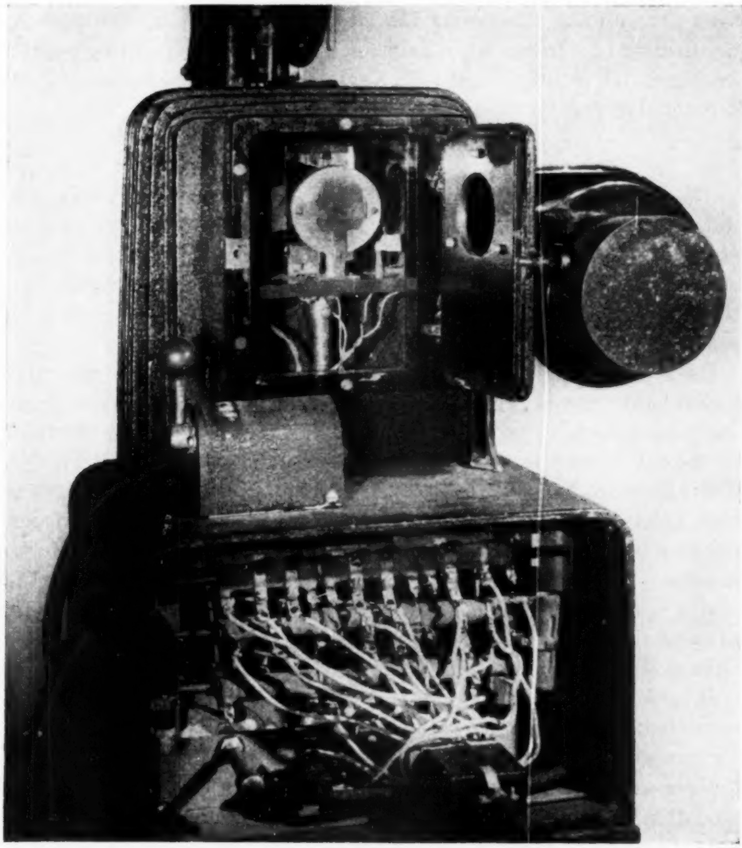


Fig. 3. Rear view of printer with the lamp-house door open. The three potentiometers shown below the adjustable resistance banks provide red, green and blue light control with the key shown in position on the "red" potentiometer.

remain lit during contact interruptions when the lights are "dropped." When the base light is off, it is possible, by a zero setting on the board, to print with the intense color of one or two of the three near-monochromatic lights.

A raw stock pre-exposing unit, called a shadow-flasher, is located just ahead of the feed-in sprocket. It consists of a light chamber, a miniature lamp, a Wratten filter holder, and a film guide channel. The lamp is under-volted and resistance-controlled. The raw stock is normally routed through the shadow-flasher before joining with the color original and the timing film at the feed sprocket. To prevent the fogging of a frame when printing is stopped, the printing control master clutch is interlocked with a safety switch in the flasher circuit. A manual switch for the shadow-flasher is also provided.

The Tricolor Printer Setup

The tricolor printer furnishes additive color correction. Owing to the narrow pass-bands of the color filters in use, it is possible to compensate effectively for changes in color temperature of the incandescent lamps when the timing resistor settings are determined. This timing advantage is not available with conventional single-pack color printers.

Each printer light change is preset to be about 70% of the next higher light. Seven printer lights are assigned to each of the red, green and blue colors. The three printer filters were selected on the basis of the layer sensitivity peaks of Kodachrome stock. The Wratten filters used are No. 29, No. 64 + No. 15, and No. 49. The top light in each color is adjusted by the appropriate rheostat so that tricolor printing of a black-and-white step-wedge is well duplicated on Kodachrome. Allowance has to be made for the current processing shifts in dye balance. The tricolor top light exposure is normally adjusted to be of the order of 60 mcs (meter candle seconds), while the lowest light averages about 6.5 mcs (Fig. 4).

It is essential that the normal or "center" light of a color printer be corrected by its color pack to duplicate an original gray scale test. Timing above or below the center light will shift the printed color balance away from "white" in accordance with the color temperature deviations which are produced. On the tricolor printer, this white-light balance is adjusted by the resistance presets to be provided whenever an equal number timing-light triplet is set up at the drop-board. For example, the nearest match to the gray scale test original

should be printed when the board is timed red 4, green 4 and blue 4, *i.e.*, the "center" light.

The three sets of seven timing lights are coded zero to six inclusive, with the center light triplet adjusted to duplicate closely a test gray density of 1.4. The seven coequal "white" combinations provide 30% of exposure change per step, each of which roughly corresponds

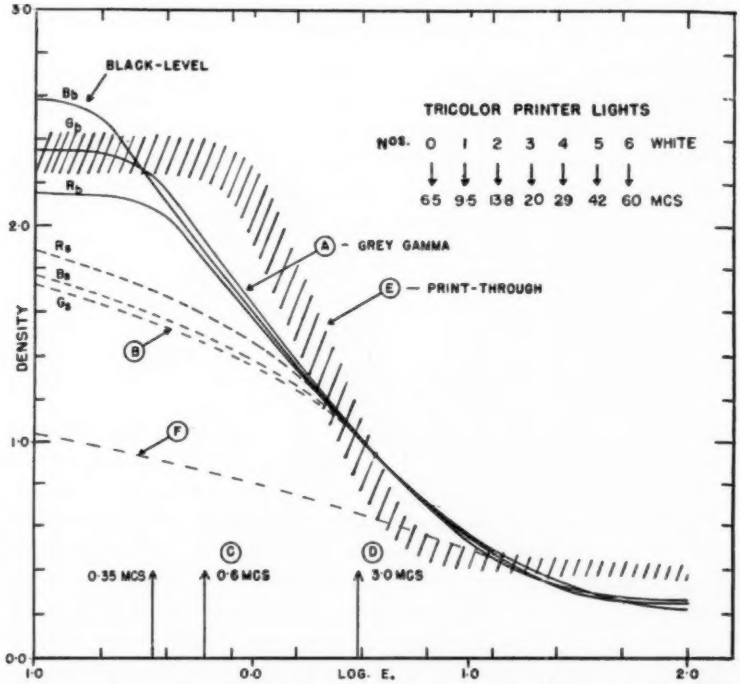


Fig. 4. Composite of relative gamma changes produced by "shadow-flashing." The printer exposures in terms of "white" timing lights are indicated relative to the resultant density of Kodachrome stock 5265.

to about three standard lights on a black-and-white printer. Single-color light changes on the tricolor printer give rise to relative hue shifts of approximately 10%. This has proved to be a satisfactory unit of change for average color-cast corrections.

All adjustments to the shadow-flasher unit are based on film density measurements. Small adjustments are effected through series resistors. The initial light output of 800-mcs exposure capacity is re-

duced by a pack of neutral density and color filters to about 0.6 mcs of equivalent cyan exposure. Less than 10% of the relative red exposure is transmitted. The green intensity is adjusted to provide about a 100% increase in green transmission over the unexposed film density value. The blue density is lowered by about 140% increase in transmission. The determining factors are discussed later under "Pre-Exposure Considerations."

SENSITOMETRY

It was desirable to introduce a minimum of change from the existing black-and-white routine. A Kodak IIb Sensitometer, balanced to expose a good gray scale, was supplied with six additional sharp-cutting Wratten filters. All filters were corrected by neutral density to a common transmission value, and all exposures were compensated to be equal to the gray scale exposure.

The following Wratten filters are used:

Wratten No. 15	Yellow	530 to 700 mμ
64	Cyan	440 to 540 mμ
34	Magenta	440 and 680 mμ
29	Red	680 mμ at peak
64 + 15	Green	540 mμ
49	Blue	440 mμ

Relative transmission relationships are measured on the Western Electric densitometer fitted with tricolor filters. For convenience, all the hue exposures are plotted in terms of the equivalent gray gamma.

These color-scale exposures provided informative hue transmission relationships for timing information. For example, blue, green and red gammas, when examined at the step which is equivalent to 20 mcs of gray exposure, exhibited blue, green and red color densities of 3%, 7½% and 30% transmissions respectively. The lower chromaticity mid-tones, usually encountered in practice, tend to equalize such transmission differences. However, the familiar red build to flesh tone shadows is violently accentuated in a second generation print and the fault cannot be ignored.

An unexpected effect was disclosed in tricolor gammas of the cyan test (Fig. 5). The density to red was found to increase whenever the cyan exposure corresponded to an equivalent gray of 0.35 mcs or more. A cyan pre-exposure of this value was found largely to prevent a red gain in the corresponding steps of yellow gammas. Accordingly, the shadow-flasher pack is prepared on the basis of the cyan and yellow tests.

The wafer-probe light meter is used weekly to establish tricolor printer exposure values co-ordinated with the current processing drifts through the six color gamma tests. A silver-image loop of a resolution chart and a gamma strip is used to test the seven "white" printer-light timings.

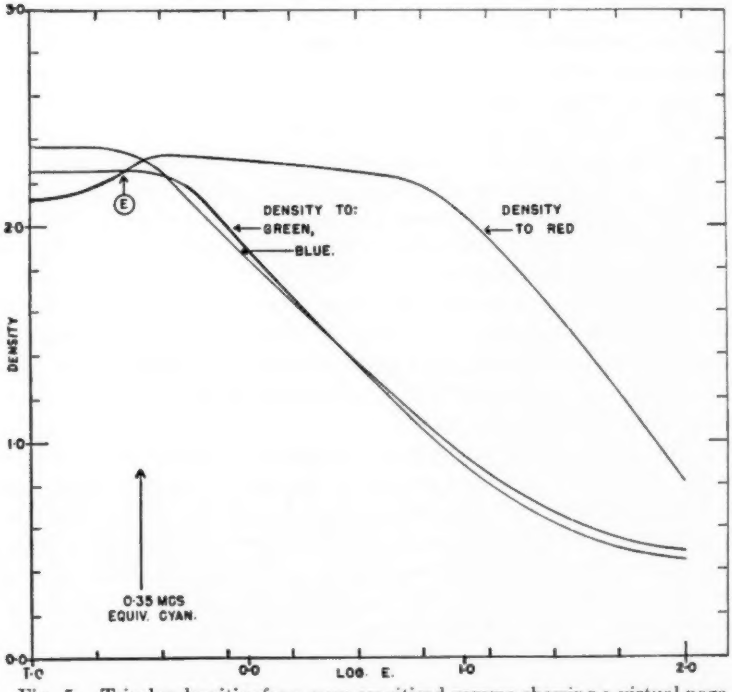


Fig. 5. Tricolor densities for a cyan sensitized gamma showing a virtual negative red exposure effect starting at E. No equivalent crossover appeared in characteristic curves for other hues.

TRICOLOR TIMING

Balanced color originals which exhibit faulty exposures are given almost conventional black-and-white timing practice. For timing purposes, any horizontal equality of the tricolor printer timing numbers is regarded as a single printer light, for example, blue 3, green 3 and red 3 become "light three, white." However, white is not directly estimated. Tricolor timing depends upon the green exposure

which is estimated first. The red and the blue layer exposures are then estimated as two corrective "color tilts" given to the horizontal or white balance. In fact, the expression "color tilt" has come to denote the timing intent as distinguished from the original, visible color fault. The resultant complementary hue bias which may be generated in the printer is seldom directly considered in rapid timing operations.

As an example of tricolor timing, assume that the precise red and green proportions of the flesh tones of a given face are to be matched across two scenes which have been cut together. It is decided to correct the whiter face scene by a timing card code of B4, G4 and R5. This plus-one-R tilt should print with a 10% red boost in all compound colors in the original provided that layer latitude for the hue shift is available in the part-image considered. The untilted G4–B4 timing would be used with indoor scenes or strong blue sky highlights. Originals with medium blue skies will duplicate with a shift to cyan[1] which the red boost would tend to gray. In such a case, the color timer will also tilt up the blue with a B4, G3 and R4 light assignment. Note that this is effected by dropping the red–green slope by one light. This is done in order to avoid the feeling of overexposure which would result from a B5, G4, R5 timing.

In practice, color printing is complicated by the existence of dual color-cast problems. The differences in opacity to red, green and blue which comprise the black-level base densities, shown in Fig. 4 at the 2.2 to 2.6 density region, are variables which depend on the conditions occurring at the processing time. The density differences, as shown, may invert to any order and may range up to a displacement of 20% or more between the tricolor transmissions.

During projection, this black-level color of an original is of negligible importance. However, when the original is underexposed, normally mid-tone images tend to be shifted toward the 2.0 density region. These images partake of the hue of the current processing dye-balance, while images whose densities range around the 1.5 level may continue to exhibit the more noticeable color-cast effects of trilayer mismatch in the original shooting color temperature.

It will be apparent that whenever an underexposed sequence is "timed up" in printing, the prevailing process hue will modify the color of the restored mid-density images. At the same time, the original mid-tone color-cast, if any, will tend to be duplicated as an unrelated color-cast which may appear in the lighter tones. A nicety of

good judgment is required to achieve a satisfactory compromise in the tricolor corrections for a key film. It should be noted that such dual color-casts often present a greater problem when conventional black-and-white timing practices are used for release printing directly from the color original.

A misleading tricolor timing problem is presented when both an overexposure and a color-cast occur in the original. In this case, the color compensation selected to offset the color-cast of the middle densities may greatly modify the pastel shades of the lowest densities present. The lowered printing exposure which is indicated tends to duplicate the overexposed near-white areas as light grays* which may be noticeably tinted with the color of the offset used. When such a duplicate is screened, visual adaptation tends to cancel out the tint. Provided that the area in question is a large one such as the sky, then images of mid-densities on the screen will be affected by the same color adaptation. An illusional color-cast is thereby created which has the complementary tint to the printer offset employed. To counteract this illusion which is, of course, the same in hue as the color-cast in the original, it is necessary to raise the chromaticity of the color correction used until direct inspection shows a hint of it in mid-gray image-parts of the duplicate.

The presence of color-casts in the key film is fortunately not a major problem when release printing. Any reel-length over-all color-cast may be easily offset by an appropriate color-correcting filter. The key film dye-balance color requires no additional color pack changes provided the printing can be done on center light.

Owing to the low latitudes involved, the center light duplication of spectral densities of the order of 2.0 tend to print below the black-level. The shaded print-through gamma curve E shown in Fig. 4 indicates the average final latitude available. It will be appreciated that little opportunity exists for any timing exposure excursions unless some method of compression is introduced.

PRE-EXPOSURE CONSIDERATIONS (Shadow-Flashing)

The flashing of the raw stock by a white-light exposure of about 0.35 mcs will lower the tricolor gamma. As shown by curves A in Fig. 4, exposures below this level are not visibly recorded. The ad-

* See Fig. 4. A completely overexposed original with a transmission of the order of 60% (a density of 0.2) is reproduced by light No. 1 as a gray of only 20% (a density of 0.7).

dition of the above flash to each step not only shifts the point of shoulder inflection but it also produces a chromaticity limit to shadow details. In addition, any processing dye-balance color-cast tends to become more predictable—a useful feature when black-and-white timed duplicates are directly printed from the original. Flashed raw stock may be used for second generation duplications but the release film blacks should project as visually normal. Release film shadow-flashing is, therefore, definitely limited to the inflection point of the curve.

The differences between the relative gammas of the primary colors has been fully discussed in the JOURNAL.[1-3] They are the cause of the familiar red build-up which sometimes characterizes the shadow sides of faces. Various approaches to the problem, such as the intentional printing of a cyan color-cast or the use of a red light mask,[1] have been employed. However, shadow-flashing with cyan light proved a convenient control measure. The density to red at the black-level has been shown to increase when a cyan exposure is used (Fig. 5 at E). This process fault is most useful because of the concurrent reduction to the chromaticity of dark reds provided by the cyan transmission increase.

In practice, a higher shadow-flash than 0.35 mcs is needed for the key film stock. The compensation for a 2.25 red gamma which is the product of two generations of color printing would require a key film red gamma of approximately 0.45. Shadow-flashing with a predominantly cyan light (Fig. 4, C) of about 0.6 mcs is seen to produce a region of gamma of this order as manifested by the curves at B. The release printer light is adjusted to duplicate as neutral black the key film shadow-flash density levels R_s, B_s and G_s. The relatively greater density to red (R_s, to G_sB_s) of about 0.1 is required in order to compensate for the low cyan gamma of the final duplicate.

The existence of the shadow-flash "floor" permits the timer to concentrate on the maintenance of highlight details. Only shots possessing no near-whites require higher than a center-light exposure. The effect of shadow-flashing extends even to the mid-densities in counteracting possible dye-casts so that the hue substitutions of the original become the color timer's major consideration.

Precautions must be taken, however, not to make an automatic practice of undertiming because of the resolution losses which may be incurred. The resolution of details is not only a function of the grain size possessed by the silver images before bleaching; it is also de-

pendent upon the degree of density excursion forming the image details. For colored images, each increase in color density can be expected to exhibit lowered resolution. The density differences upon which picture details depend are thus reduced by lower timing. The following resolution figures give some idea of the definitions to be obtained when printing pure hues through a resolution chart two lights below normal:

			B	G	R		*lines/mm*
Black-and-white resolution on:	Center Light		4	4	4	→	55
	Red	"	0	0	2	→	17
	Green	"	0	2	0	→	25
	Blue	"	2	0	0	→	35

A gain of up to 15 lines/mm occurred when equivalent center-light pure hues printed the resolution charts. The reduction in maximum contrast due to flashing affected the practical color resolution by a loss of about 10 lines. In any event, the resolution losses from shadow-flashing do not begin to compare with the total loss of detail that occurs when portions of an image are cut off by printing below the gamma shoulder of non-shadow-flashed Kodachrome film.

NOTES ON MASKING

While the various relative-brightness silver masks produce contrast reduction as outlined,[1] their routine use for one-light printing seems contraindicated. Such masks, either unsharp[4] or the more convenient sharp masks defocussed by double film base thicknesses, have printed uncommercial amounts of halo around those image fimbrillations which have extreme contrast.* Very lightly printed blue-sensitive masks for the reel-length equalization of skies show possibilities but timing complications ensue if full masking with tinted base panchromatic stock is used. For obvious reasons, negative masking cannot be used with overexposed scenes. Also the whole feasibility of masking is modified by the additional corrections which are required for the second generation duplicate.

A different proposition altogether is the use of color film for the masking of overexposed scenes. Wherever such scenes occur, it is desirable to accentuate the relative hues and contrasts. A conventional color print cannot be used as a mask, however, as normally ex-

* In this connection, it has been noted that, for masking registration purposes, neither the film direction nor the perforation sides are interchangeable.

posed images are always present in overexposed shots. For this reason, it is important to limit both the chromaticity and the gamma of the positive mask. This may be achieved by preflashing the masking stock. A white flash of approximately 3 mcs (see step D, Fig. 4) will set up a maximum minus density of about 10% transmission to all hues. The optimal value is not critical, nor is the time lapse between flashing and use, but the fogged stock should be pretested to ensure a neutral gray.

The overexposed original is printed onto this stock by center-light or lower. Provided that exact registration is used, the resulting pastel colored mask is an effective compensation means. The low mask gamma (about 0.35 γ, Fig. 4, curve E) largely avoids the problem of halos. Also the relative color and density shifts co-operate visually. The chroma-boosting is such that no exception to the routine timing and shadow-flash procedure is required. Full gamma Kodachrome masks used in conjunction with extreme printer-light tilts have provided endless combinations for special effects.

General Over-All Procedure

Expressed in printing vernacular, the production of a 16-mm key film intermediate follows this pattern:

The original is checked and very thin scenes are papered. Using the white fogged stock (3 mcs), the chroma-boosting masks are center-light printed between the papers.

After processing, the masks are frame synchronized with their originals by clear leader.

A first run-through is made over the (color) light box to judge the printer lights and the green exposure is set up on the timing card. Double timing from previous notches on the original is avoided by notching on the masking roll.

The color corrections are next estimated and the red and the blue timing tilts are entered on the timing card. Overexposed scenes are superimposed on their masks when viewed for timing.

The notched mask is then synchronized tail-out behind the original in the tricolor printer. Finally, the tricolor drop-board and the shadow-flasher are preset, the raw stock is threaded and the key film is printed.

Present Results

The major disadvantage to the practice of printing from key films lies in the resolution losses incurred at the 2.0 density region. A

limitation to the maximum chromaticity also occurs at the same region, but specific hue-shifts are considered to be less objectionable when the chromaticity is thus reduced.

Other observations on test prints made from key films have demonstrated:

A contrast of the same order as the original.

Improved maintenance of original shadow image densities.

Increased average transmission, jointly with improved reproduction of highlight areas.

Reduced color-shifts on a scene-to-scene basis, when compared with the original.

Reduced color-casts.

Reduced exposure changes.

Reduced effects from relative-brightness color-shifts.

Increased chromaticity and contrast from overexposed originals.

Increased chromaticity; reduced gray contrast for special effects.

In view of the opportunities for greater production control which are presented by the use of an intermediate stage, it is felt that the key film method can be the basis of improved release quality in 16-mm color.

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DISCUSSION

MR. WILLIAM OFFENHAUSER: I think this paper is a great contribution. I don't think at the moment that its import is fully appreciated, but we have for many years needed some analysis of second and later generation Kodachrome prints and some means to overcome their difficulties. There are a number of very fortunate things on the horizon. Now that the color control problem is reasonably well within view of solution, we have left the major problem of deterioration in resolving power; and from all that I have been able to hear, mostly through what we might call the underground, that solution, too, is in sight. So it may not be very many years before we will be able to accomplish the objective of having an original, storing it away for many years and yet being able to derive, let us say, third generation and further generation prints for use in the 16-mm fields. The goal is in sight.

Illuminating System and Light Control for 16-Mm Continuous Optical Printer

By WILLIAM BORNEMANN and WAYNE McKUSICK
Eastman Kodak Co., Rochester, N.Y.

Summary—**A continuous optical printer for producing highly corrected release prints at rapid printing speeds from 16-mm color originals is being developed and tested by the Eastman Kodak Co., Rochester, N.Y. All information on level and color balance of the printing light for each scene may be stored on the master film and the cuing device eliminates the necessity of notching the film. Also incorporated is a sprocket which automatically accommodates highly shrunk and damaged film inter-cut with fresh originals.**

The increasing demand for high-quality release prints from 16-mm color originals poses problems not readily solved by modifying existing printers. Since some original camera film may be included in the printing master from which the release prints are to be made, the requirements imposed on a color printer are indeed stringent.

First, release prints must be turned out at high speed; yet the extremely valuable original film must not be worn out until a profitable number of copies has been obtained. This requirement has been met in this experimental model by using precision gears to register the two sprockets of a continuous optical printer. Thus the film can be driven at high speed without the characteristic wear and damage of an intermittent film drive, or the abrasion of contact printing. The handling of the original film is further facilitated by an invaluable device which we call our "compensating sprocket." This is a sprocket which changes pitch continuously throughout the angle of film "wrap" and hence smoothly handles a wide range of shrinkages as well as worn or broken perforations.

Secondly, it has been found empirically that any change in exposure or color balance must be accomplished within one frame in order not to be objectionable when the print is projected. If, for example, the speed of the printer is set at 100 feet/min, then changes in color balance or exposure must be accomplished within 15 milliseconds; higher printing speeds obviously would require a proportionately faster action. Since the original film may vary

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widely in exposure and color balance because of the unavoidable conditions under which the shots are made, a *wide range* of correction is needed in each color in a release printer. But *small* corrective steps in each color are required in order that the continuity of color from scene to scene be accurately maintained. Thus, the total number of possible combinations of printing level and color corrections is staggering.

If one chooses values of optical density according to the geometrical progression 1, 2, 4, 8, 16, up to n and arranges to interpose any combination of these densities into a beam of light, then he has made available 2^n equal steps of light intensity. If then three beams of the same intensity, but each of a different primary hue, are so filtered and combined at the slit of the printer, a unit density may be chosen to give the desired fineness of color correction, and the value of n to give the necessary range.

In our experimental model, three condenser relay systems with the aid of multiple-layer selective reflectors combine three primary

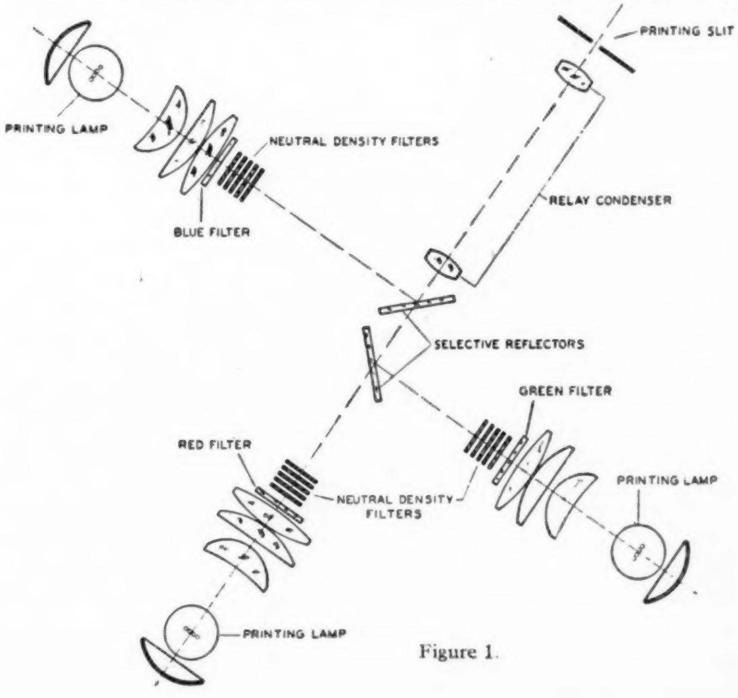

Figure 1.

beams, while solenoids move the corrective filters with the required speed (see Fig. 1). In order to use this range and speed of control, one must first assign to each scene of the original film a printing level specified in terms of the desired intensity of each of the three primary beams. This information must then be stored in such a way that it can reappear and alter the printing light at the beginning of each scene. Again selecting 100 feet/min for purposes of example, a one-foot scene would allow six-tenths of a second for "clearing the memory" and feeding in the prepared information of the following scene.

The memory system selected for storing the scene-by-scene printing information is a narrow track of magnetic material applied to the master film between the perforations and the edge of the film. If five filters are used in each of the three primary beams as described above, giving 32 steps in each color, then the conditions for printing any given scene may be specified by demanding that certain of the 15 filters (5 in each color) be interposed in their primary beams. Thus is established not only color balance but exposure as well. In a special viewer-recorder equipped with a magnetic recording head, we put down on the magnetic track at the beginning of each scene a series of 15 pulses corresponding to the 15 filters—each positive pulse calling for that particular filter to appear in its colored beam for the next scene, and each negative pulse specifying that the corresponding filter remain out of its beam. Positive and negative pulses are produced by opposite polarity on the coil of the recording head. Following this sequence of pulses, a triggering pulse is put down on the magnetic track, the function of which will become apparent below.

As the "color-timed" master film is run through the printer, the fifteen pulses pass a magnetic playback head on the printer before the corresponding scene reaches the printing "gate." This pattern of positive and negative pulses is electronically stored until the triggering pulse reaches the playback head, at which time the pattern is delivered to the solenoids that actuate the filters, accomplishing the entire light change within the first frame of the new scene.

By this approach to the problem not only is the printing information permanently stored as an integral part of the original film, but also the cuing of light changes is accomplished without notching the film. Both the printing information and the triggering pulse may be erased and re-recorded as desired, facilitating subsequent editing and refinement of printing conditions to give a maximum of color continuity throughout the release print.

New Brenkert Projection System For Drive-In Theaters

By C. N. BATSEL
RCA Victor Div., Hollywood, Calif.
And H. J. BENHAM
Brenkert Light Projection Co., Detroit, Mich.

Summary—Some of the limitations and handicaps in illuminating large drive-in theater screens are discussed. The basic requirements for adequate screen lighting are reviewed and a newly developed arc light and projection system meeting those requirements are described.

The popularity of the drive-in theater started to accelerate during the war and soared to undreamed-of heights. Perhaps one reason for this rapid rise in popularity was that the drive-in theater gave people, who were in a war plant all day, a chance to relax and see a picture out in the open air and in a picnic-like atmosphere. Since the war, the popularity of the drive-in theater became even greater and, as a result, there is still a wild scramble to build drive-in theaters in all parts of the country.

Vast improvements have been made in the design of drive-in theaters compared to those built prior to the war: Buildings and grounds have been beautified; services such as ultra-modern snack bars and kiddies' playgrounds have been incorporated as added attractions; and parking areas have been increased in size so that many theaters will now accommodate over 1,000 cars. RCA pioneered in designing and building sound reproducing equipment especially for drive-in theaters so that good quality sound could be reproduced in every car through a neat and attractive in-car speaker. Producing a picture that can be clearly and easily seen by the occupants of all the cars in drive-in theaters, however, has always beeen a difficult task up to the present time.

There are a number of factors that contributed to the difficulty involved in high-quality projection for large drive-in theaters:

1. Long viewing distances between the cars in the rear ramps and the screen, in some cases over 850 ft. Detail of the picture, even

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though it may be 70 ft wide, is rapidly lost at these distances because visibility is lessened and the elements also interfere and cut down on detail.

2. Long projection throws of 300 ft or more. Here again interference of dust, mist, fog and rain have a deleterious effect on picture quality.

3. Extremely large picture areas, some over 3,000 sq ft. It is extremely difficult to provide adequate illumination over picture areas of this size so that the people in cars in the rear and on the sides of the parking area can see details.

4. Wide viewing angles, particularly at the ends of the front ramps. This is a limitation only for those cars at the extreme sides and reasonably close up front, and is a limitation that cannot be remedied except by changing the shape of the parking area with a considerable loss in productive area.

5. Moonlight and other interferences such as electric signs, highway lights and street light.

The net result of these limitations is that most drive-in theaters have pictures that are considerably inferior to those in regular indoor theaters. It is also quite apparent from the nature of these limitations that by providing a sufficient amount of projected light the quality of the drive-in theater picture could be considerably enhanced. Very little work has been done in establishing the lighting values for outdoor screens; consequently, there are no standards such as we have for indoor screens. It is generally conceded that for the same viewing distances, large screens do not need so much illumination as smaller screens to permit the viewer to see an equivalent amount of detail. Recent observations and measurements of present screen illumination in outdoor theaters indicate that a 50% to 100% increase from present levels is necessary if the picture quality is to be materially increased. Such an increase in illumination will bring the light on large screens up to 6 ft-c at the center; this will provide reasonably satisfactory quality of projection under all but the most extreme conditions. A field flatness of at least 70% is desirable, but reasonably good picture quality can be had with a field flatness as low as 60%. Lighting values such as these can be obtained on screens 35 to 40 ft in width using standard projector mechanisms and suprex-type arc lamps.

A super high-intensity arc lamp, burning 13.6-mm high-intensity positive carbons at 150 amp operated in combination with a projector

equipped with double disc-type shutters and using $f/2.0$ condensers and projection lenses, will deliver approximately 7.6 ft-c at the center of a screen 40-ft wide, with an 80% light distribution.[1] This same projection system will deliver approximately 3.5 ft-c at the center of a 60-ft screen with the same light distribution. Increasing this light intensity beyond these values is not very practical mainly due to heat problems that arise and the probable damage to film, unless some adequate means of cooling is provided.

Heat-absorbing glass is sometimes used to reduce the heat on the film, but all known glass heat filters absorb a considerable amount of the visible light rays as well as change the color of the projected light. The net result is a visible loss of considerably more than that indicated by a photometer with a Viscor filter. Light measurements made using arc lamps operated at 170 amp with heat filters actually give screen results which are inferior to those when using the same arc lamp operated at 150 amp without the heat filter. Other methods of cooling, such as by water-cooled apertures, do not provide adequate protection to the film.

The light projection problem therefore resolved itself into the following objectives:

1. Obtaining a carbon capable of producing approximately 26,000 lumens on the screen without the projector running when operated at its rated current so as to obtain at least 6 ft-c at the center of a 60-ft screen.

2. Designing an arc lamp capable of operating satisfactorily using high-current carbons of this type, yet flexible enough so that it will perform equally well when operated at lower currents.

3. Designing a new film trap and gate assembly with associated cooling system permitting transmission of maximum light from the arc lamp to the screen.

All of these objectives have been met with the introduction of new projection and arc lamp equipment known as the Brenkert Supertensity system and developed by the Brenkert Light Projection Company. Incorporated in this system are methods for adequate cooling of the arc lamp, projector and film so that this system can be operated with high amperage carbons at the full current rating of the carbon and without damage to the film or the equipment. Using this system with the 13.6-mm super high-intensity carbon it was possible to use the maximum amount of light developed when these carbons were operated at their maximum rating of 170 amp without employ-

Fig. 1. Supertensity Lamp.

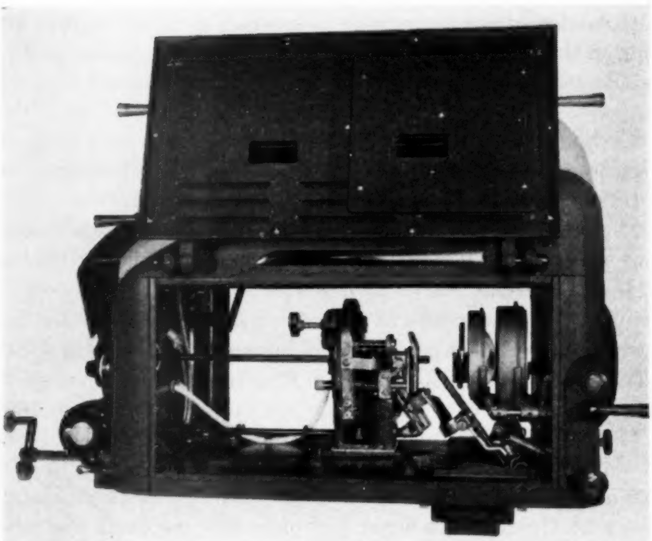


Fig. 2. Interior of Supertensity Lamp; showing positions of lenses, carbon feeds, mechanisms and air outlets.

ing light-wasting and color-changing glass heat filters. This was more light than was ever used before without glass heat filters to prevent film damage.

With this new Brenkert Supertensity system, however, even more light could be used, without damaging film, than could be developed by the 170-amp 13.6-mm super high-intensity carbon. The new 13.6-mm "Hitex" Super carbon recently announced by the National Carbon Division offers such a possibility of increased light. This carbon is rated at 170 to 180 amp; the trim is complete, using a ½-in. heavy-duty Orotip negative. When operated at 180 amp in the Supertensity system approximately 7 ft-c can be projected on the center of a 60-ft screen with approximately 70% screen distribution. The light produced when operating this new "Hitex" carbon at 180 amp is much whiter than that produced by the Supertensity system and standard super high-intensity carbon when operated at 170 amp, so that to the eye the light on the screen appears greater than indicated by a photometer.

THE ARC LAMP

In designing the lamp house consideration was given to such things as ease of operation, cooling, placement of the carbon feed mechanism and appearance. The housing is extremely large by comparison to other arc lamps, having a content of approximately 10 cu ft, which aids in cooling and at the same time greatly facilitates operation, servicing and cleaning.

The walls of the housing are hollow, with intake ventilation vents around the bottom through which air enters, passes up through the walls and exhausts through vents located around the stack port at the top. Forced ventilation is supplied to the interior of the lamp by a fan which is driven by the carbon feed motor. Air from this source is passed through ducts which are part of the base casting and terminate under the positive feed, the carbon feed and the negative carbon holder. The entire lamp house is constructed of solid aluminum castings, completely lined and ventilated to prevent its becoming excessively hot and warping out of shape. This is especially important to permit an accurate arc image to be projected on the arc-image screen.

The positive carbon feed mechanism uses a three-roller head which, while rotating the carbon, feeds it toward the arc; grease-packed ball bearings are used throughout. Many new and very desirable features are incorporated in the design of this new positive carbon feed

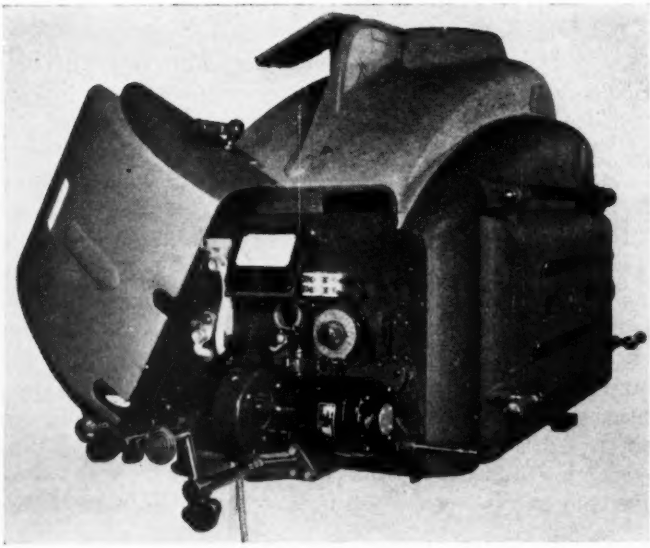


Fig. 3. Rear view of Supertensity Lamp; showing arc current meter, hand carbon feeds and motor feed mechanism.

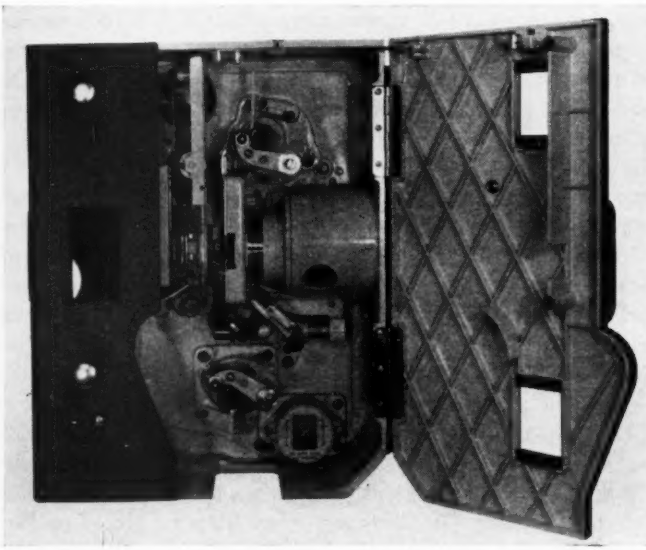


Fig. 4. View of BX-80 Projector; showing air jet position.

mechanism. The three-feed rollers are $\frac{3}{4}$ in. in length and the full length of each roller contacts the carbon at points equidistant on the circumference of the carbon with a pressure of approximately 50 lb existing between the rollers and the carbon. Thus, positive feeding of the carbon is assured at all times; tests at the factory have proved that it is impossible to stall the carbon while the feed mechanism is in operation. Accurate alignment of the carbon is assured regardless of the length of trim because of the three-suspension method of holding the carbon and because of the proximity of the rollers to the arc. The positive carbon brushes are located directly in front of the feed rollers. The carbon passes through a high heat baffle to the crater point. This baffle protects the mechanism and serves as an air guide to prevent the forced air ventilation from disturbing the arc. The linear dimensions of the feed mechanism brushes and baffle are short, permitting the carbon to be burned to a stub of approximately $3\frac{1}{2}$ in. Current feeds to the carbons are symmetrically arranged to assure perfect magnetic balance regardless of operating current values and without the use of auxiliary permanent magnets. This results in a white and unwavering light on the screen at all operating current values.

The negative carbon feed is placed alongside the positive feed. An L-shaped arm supports the negative carbon clamp. This construction keeps all gears and moving parts away from the intense heat of the light beam, reducing heat deterioration of the parts considerably. The forced air cooling makes it possible to eliminate the necessity of using graphite lubricant; ordinary motor oil is used throughout the lamp for lubrication.

The carbon feed motor, the ventilating fan and all controls are placed at the rear of the lamp with the hand-feed cranks extending through the cover. The arc current meter is also visible through the cover, permitting easy reading of the arc current at all times. The carbon positions are indicated on the large ground glass screen which is located on top of the lamp, and can easily be seen at all times from any position in the booth.

Manual striking of the arc is accomplished by operating a lever located at the right rear of the lamp. This operation raises the negative to contact the positive and then allows it to fall back quickly into operating position when the lever is released. Using this type of arc striker, the arc can be struck at full rated operating current without danger of damaging or cracking the arc crater.

The lamp is equipped with high-speed $f/2.0$ condensers. The condenser next to the arc is fused quartz; the front one is Pyrex. This complete lens assembly is adjustable laterally, vertically and forward and backward so that it can be properly positioned to obtain maximum screen brightness and uniform distribution. The condensers are protected during striking by a hand-operated dowser. This type of condenser system is recommended wherever maximum light on the screen is the prime factor. The standard, less expensive Brenkert condensers can also be used in this lamp for indoor theater use where flatness of field is the prime factor and high efficiency light transmission is not so important.

THE PROJECTOR

Safely transmitting the unrestricted light from the arc lamp through the projector and film necessitated some revolutionary changes in design of the film side of the projector. In addition to protecting the film from heat damage, the parts of the projector exposed to the intense heat in the light beam had to be constructed of very high heat-resisting materials and had to be adequately cooled. The projector selected for this modification was the Brenkert De-Luxe BX-80. In addition to its inherent rugged construction, the BX-80 is equipped with double rear disc-type shutters. This type of shutter construction has the advantage of passing more light with less heat on the film than a projector mechanism using front and rear disc-type shutters or barrel-type shutters.

The film trap and gate assembly is designed and constructed to cope with the heat problem by making use of high-heat-resistant reflector baffles at the point of light entry to the film trap assembly. Fire shutters are constructed of metal which is highly heat resistant.

Cooling of the film and gate assembly is accomplished by using compressed air. The effectiveness of this type of cooling is dependent on several factors such as air pressure, velocity and the manner in which the air is directed onto the film. The entire film trap assembly is also effectively cooled by this air. Water-cooling the metal parts of the film trap around the aperture was tried but was discarded as unsatisfactory.

The maximum heat in the light beam at the aperture is on the emulsion side of the film. This heat, which is energy absorbed, is proportional to the density of the image on the film. It is also somewhat

greater at the center of the aperture than at the sides. Distribution of the air stream must, therefore, be such that sufficient air contacts all parts of the film so as to absorb the heat and carry it away. The metal parts of the film trap and gate are automatically cooled by the air as it is exhausted from around the film trap assembly.

The proper application and distribution of the air stream is obtained by specially designed jets. They are placed front and rear of the film and positioned so that air is ejected horizontally against the film. The jets are on the side of the gate next to the center plate of the projector and the air is blown toward the operating side of the mechanism.

The volume of air directed against the emulsion side of the film is somewhat greater than against the front or base side of the film. Flutter and consequent focus trouble are completely eliminated by proper construction and placement of these jet nozzles.[2] The angle at which the air strikes the film is also important in this respect.

Air is piped to the projectors from a pump which is usually installed in the motor generator room. One reason for using an air pump is to supply air completely free of oil, something which cannot always be done with a regular piston-type compressor. A silencer and cleaner are attached to the air pump to reduce the noise and dust in the air.

A number of these installations have been made in several parts of the United States, many of them more than one year ago. The picture quality at the drive-in theaters using this system is far superior to anything ever seen before in a drive-in theater.

Lighting standards which were mentioned previously in this paper are not intended to be optimum, but it has been proven that, if the larger drive-in theaters would bring their screen illumination up to these values, a very desirable improvement in projection could be obtained.

REFERENCES

(1) *National Projector Carbons*, 4th Ed., National Carbon Div., Cleveland, Ohio, 1949.

(2) F. J. Kolb, Jr., "Air cooling of motion picture film for higher screen illumination," *Jour. SMPE*, vol. 53, pp. 635–664; December, 1949.

Note on Metol Analysis In Photographic Developers

By MARTIN IDELSON

Technical Dept., Pavelle Color Inc., New York, N.Y.

The method of Brunner, Means and Zappert[1] for the determination of metol in Ansco Color Positive first developer, A-502, was found by us to give a titration curve with no true inflection point. Instead, there was a region of about 0.5 ml in which the inflection might occur; therefore, the error in the determination may be quite large. By substituting acetic acid for water as solvent for the titration, and 0.1 *N* sulfuric or perchloric acid in acetic acid for the conventional 0.1 *N* hydrochloric acid, a better inflection point may be obtained. No changes except those already mentioned were made in the procedure given by Brunner, Means and Zappert.

Briefly, the theory is that whether a substance is an acid or base depends on the solvent in which it is dissolved.[2,3] Nitric acid is commonly regarded as a strong acid, but when nitric acid is dissolved in concentrated sulfuric acid it acts as a moderately strong base.

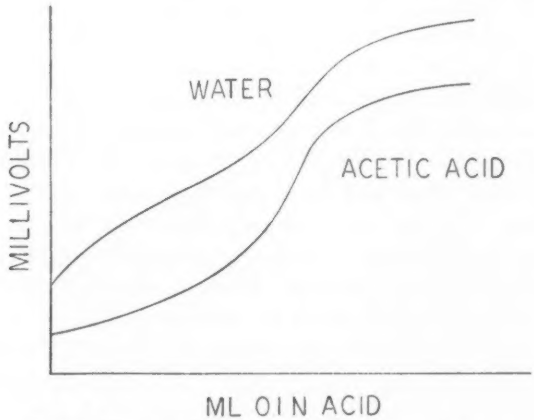
Metol is an amino phenol. In water the amino group is a weak base and the phenol group is a very weak acid. The net effect is a weakly basic reaction towards acids. If, however, acetic acid is used as the solvent, the acidity of the phenol group is completely masked while the basicity of the amino group is enhanced.

The titrant must be a stronger acid than acetic acid; sulfuric and perchloric acids are very convenient and a 0.1 *N* solution of either in glacial acetic can be accurately standardized against diphenylguanidine potentiometrically or with methyl violet indicator.

A comparison of two titrations, one in water and the other in acetic acid, is shown in the accompanying graph. On calculating the change in emf per milliliter at the equivalence point, it was found that for water the ratio was 64 mv per ml and for acetic acid, the ratio was 112 mv per ml. Furthermore, these values applied over a region of 0.5 and 0.2 ml respectively. It can be seen that the end point can be found more closely with acetic acid as solvent.

A Contribution: Submitted December 28, 1949.

It should be noted that a precipitate forms when the titration with ceric sulfate is performed. The end point is not as sharp as in water, and either a separate sample should be prepared or an aliquot part of the combined extracts of metol and hydroquinone may be used.



Comparison of typical titration curves from a metol-water sulution and a metol-acetic acid solution.

REFERENCES

(1) A. H. Brunner, Jr., P. B. Means, Jr., and R. H. Zappert, "Analysis of developers and bleach for Ansco Color Film," *Jour. SMPE*, vol. 53, pp. 25–35; July, 1949.

(2) L. P. Hammett, *Physical Organic Chemistry*, Chap. II, McGraw-Hill, New York, 1940.

(3) N. F. Hall and J. B. Conant, "A study of superacid solutions: I," *J. Amer. Chem. Soc.*, vol. 49, p. 3047; 1927.

New American Standards

Six new American standards, approved by the American Standards Association on March 14, 1950, appear on the following pages. The four which deal with 16- and 8-mm camera and projector apertures were published as proposed standards in the March, 1949, Journal, for a period of trial and comment. No criticism of the proposals was received; therefore no change in the technical content has been made.

The Standard for Mounting Frames for Theater Screens (Z22.78) was developed by a Subcommittee of ASA Sectional Committee Z22, and is being published here for the first time. The need for a standard of this type became apparent in 1946 when the revision of Standard Dimensions for Theater Screens Z22.29 was undertaken. The new standard describes good current practice and will aid manufacturers and theater owners in selecting the appropriate frame for any particular application.

The Standard for 16-Mm Sound Projector Test Film (Z22.79) is also being published for the first time. It was developed by the joint Test Film Committee of the Motion Picture Research Council and the Society as a revision of War Standard Z52.2. It describes a 16-mm version of the 35-Mm Theater Sound Test Film, familiar to many members as the old "Academy" test reel. The primary difference between this American Standard and the old War Standard is of an editorial nature. The detailed procedure for selecting appropriate sound test samples is now covered in the American Standard for the 35-Mm Film Z22.60 which was approved in 1948 and was published in the November, 1948, Journal.

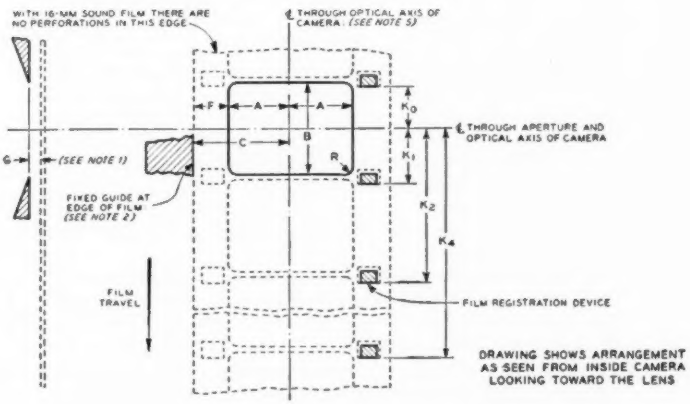
One other important change concerns the re-recording characteristic to be used in making up the 16-mm film. During the war there was no agreement as to what high-frequency equalization should be used in the 16-mm re-recording channel. Now, however, the major studios have reached an agreement, and the recommendations have been published as the Research Council Bulletin N-1.1.

American Standard

Location and Size of Picture Aperture of 16-Millimeter Motion Picture Cameras

ASA
Reg. U. S. Pat. Off.
Z22.7-1950
Revision of
Z22.7-1941
and
Z22.13-1941
*UDC 778.53

This standard applies to both silent and sound 16-mm. motion picture cameras. It covers the size and shape of the picture aperture and the relative positions of the aperture, the optical axis, the edge guide, and the film registration device. The notes are a part of this standard.



Dimension	Inches	Millimeters	Note
A (measured perpendicular to edge of film)	0.201 minimum	5.11 minimum	1
B (measured parallel to edge of film)	$0.292 {+0.006 \atop -0.002}$	$7.42 {+0.18 \atop -0.05}$	1
C	0.314 ± 0.002	7.98 ± 0.05	2
F	0.110 minimum	2.79 minimum	3
K_0	0.125 ± 0.002	3.18 ± 0.05	4
K_1	0.175 ± 0.002	4.44 ± 0.05	4
K_2	0.474 ± 0.002	12.04 ± 0.05	4
K_3	0.773 ± 0.002	19.63 ± 0.05	4
K_4	1.072 ± 0.001	27.23 ± 0.03	4
R	0.020 maximum	0.51 maximum	1

Approved March 14, 1950 by the American Standards Association Incorporated
Sponsor: Society of Motion Picture and Television Engineers Incorporated

*Universal Decimal Classification

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The angle between the vertical edges of the aperture and the edges of normally positioned film shall be 0 degrees, ± ½ degree.

The angle between the horizontal edges of the aperture and the edges of normally positioned film shall be 90 degrees, ± ½ degree.

Note 1: Dimensions A, B, and R apply to the size of the image at the plane of the emulsion; the actual picture aperture has to be slightly smaller. The exact amount of this difference depends on the lens used and on the separation (dimension G) of the emulsion and the physical aperture. G should be no larger than is necessary to preclude scratching of the film. The greatest difference between the image size and aperture size occurs with short focal-length, large diameter lenses.

Dimensions A and B are consistent with the size of the images on a 16-mm. reduction print made from a 35-mm. negative with the standard 2.15 reduction ratio.

It is desirable to hold the vertical height of the actual aperture to a value that will insure a real (unexposed) frameline. This results in less distraction when the frameline is projected on the screen than is the case when adjacent frames overlap.

Note 2: The edge guide is shown on the sound-track edge. This location for it has the advantage that the rails bearing on the face of the film along this edge and also between the sound track and picture area can be of adequate width. Disadvantages of this location for the edge guide are that, because film shrinkage and tolerances affect the lateral position of the perforations, the pulldown tooth must be comparatively narrow and will not always be centered in the perforation.

The guide can be on the other edge, adjacent to the perforated edge of sound film. With the guide at this edge, the width of the pulldown tooth does not have to be decreased to allow for shrinkage. However, because of variations introduced by shrinkage of film, this location for the edge guide has the important disadvantage that it makes extremely difficult the provision of rails of adequate width to support the sound-track edge without encroaching on, and consequently scratching, the picture or sound-track area. (See Section 3, Proposals for 16-mm. and 8-mm. Sprocket Standards, Vol. 48, No. 6, June 1947, Journal of the Society of Motion Picture Engineers).

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Location and Size of Picture Aperture of 16-Millimeter Motion Picture Cameras

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The film may be pressed against the fixed edge guide by a spring, by the tendency of the film to tilt in the gate, or by other means. In the second case, there is a fixed guide for each edge of the film. The important point is to have the film centered laterally on the optical axis.

Dimension C is made slightly less than half the width of unshrunk film so that the film will be laterally centered if it has a slight shrinkage at the time it is run in the camera. This is the normal condition. As indicated by the above discussion, C may be measured in either direction from the vertical centerline.

Note 3: Dimension F must be maintained only when a photographic sound record is to be made on the film that passes through the camera; otherwise F may be disregarded.

Note 4: The K dimensions are measured along the path of the film from the horizontal centerline of the aperture to the stopping position of the registration device. Both the dimensions and tolerances were computed to keep the frameline within 0.002 to 0.005 inch of the centered position for films having shrinkages of 0.0 to 0.5 per cent at the time they are exposed in the camera. For any given camera, use the value of K corresponding to the location of the registration device.

If the film does not stop exactly where the film registration device leaves it, because of coasting or some other cause, a slight adjustment of the value of K will be necessary. This will be indicated if film that has a shrinkage of 0.2 to 0.3 per cent when it is run in the camera does not show a properly centered frameline. From such a test, the amount and direction of the adjustment can be determined.

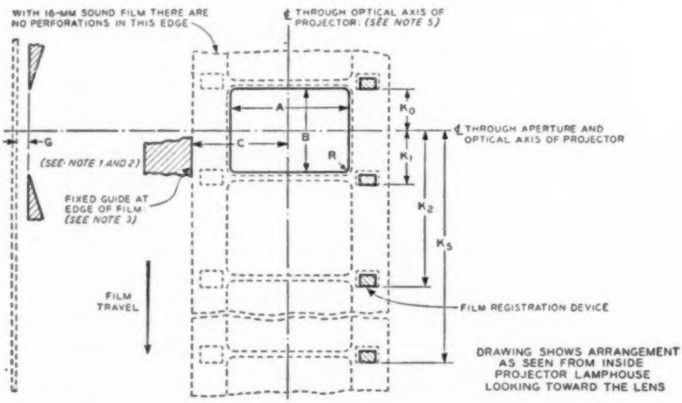
Note 5: "Optical axis of camera" is defined as the mechanical axis or centerline of the sleeve or other device for holding the picture-taking lens. Except for manufacturing tolerances, it coincides with the optical axis of the lens.

American Standard

Location and Size of Picture Aperture of 16-Millimeter Motion Picture Projectors

ASA
Reg. U. S. Pat. Off.
Z22.8-1950
Revision of
Z22.8-1941
and
Z22.14-1941
*UDC 778.55

This standard applies to both silent and sound 16-mm. motion picture projectors. It covers the size and shape of the picture aperture and the relative positions of the aperture, the optical axis, the edge guide, and the film registration device. The notes are a part of this standard.



Dimension	Inches	Millimeters	Note
A (measured perpendicular to edge of film)	0.380 ± 0.002	9.65 ± 0.05	1
B (measured parallel to edge of film)	0.284 ± 0.002	7.21 ± 0.05	1
C	0.314 ± 0.002	7.98 ± 0.05	3
K_0	0.124 ± 0.005	3.15 ± 0.13	4
K_1	0.174 ± 0.005	4.42 ± 0.13	4
K_2	0.473 ± 0.005	12.01 ± 0.13	4
K_3	0.771 ± 0.005	19.58 ± 0.13	4
K_4	1.070 ± 0.005	27.18 ± 0.13	4
K_5	1.368 ± 0.005	34.75 ± 0.13	4
R	0.020 maximum	0.51 maximum	1

Approved March 14, 1950 by the American Standards Association Incorporated
Sponsor: Society of Motion Picture and Television Engineers Incorporated

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Page 2 of 3 pages

The angle between the vertical edges of the aperture and the edges of normally positioned film shall be 0 degrees, ± ½ degree.

The angle between the horizontal edges of the aperture and the edges of normally positioned film shall be 90 degrees, ± ½ degree.

Note 1: Dimensions A, B, and R apply to the portion of the image on the film that is to be projected; the actual opening in the aperture plate has to be slightly smaller. The exact amount of this difference depends on the lens used and on the separation (dimension G) of the emulsion and the physical aperture. To minimize the difference in size and make the image of the aperture as sharp as practicable on the screen, G should be no larger than is necessary to preclude scratching of the film. When the reduction in size from the image to the actual aperture is being computed, it is suggested a 2-inch f/1.6 lens be assumed unless there is reason for doing otherwise.

Note 2: The limiting aperture is shown as being between the film and the light source so that it will give the maximum protection from heat. If other factors are more important, it may be on the other side of the film.

Note 3: The edge guide is shown on the sound-track edge. This location for it has the advantage that the rails bearing on the face of the film along this edge and also between the sound track and picture area can be of adequate width. Disadvantages of this location for the edge guide are that, because film shrinkage and tolerances affect the lateral position of the perforations, the pulldown tooth must be comparatively narrow and will not always be centered in the perforation. Also, in some prints the sound-track edge is slit after processing, in which case there is likely to be some lateral weave between this edge and the pictures.

The guide can be on the other edge, adjacent to the perforated edge of sound film. With the guide at this edge, the width of the pulldown tooth does not have to be decreased to allow for shrinkage. Also, slitting the sound-track edge after processing will not introduce lateral unsteadiness. However, because of variations introduced by shrinkage of film, this location for the edge guide has the important disadvantage that it makes extremely difficult the provision of rails of adequate width to support the

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sound-track edge without encroaching on, and consequently scratching, the picture or sound-track area. (See Section 3, Proposals for 16-mm. and 8-mm. Sproket Standards, Vol. 48, No. 6, June 1947, Journal of the Society of Motion Picture Engineers).

The film may be pressed against the fixed edge guide by a spring, by the tendency of the film to tilt in the gate, or by other means. In the second case, there is a fixed guide for each edge of the film. The important point is to have the film centered laterally on the optical axis.

Dimension C is made slightly less than half the width of unshrunk film so that the film will be laterally centered if it has a slight shrinkage at the time it is run in the projector. This is the normal condition. As indicated by the above discussion, C may be measured in either direction from the vertical centerline.

Note 4: The K dimensions are measured along the path of the film from the horizontal centerline of the aperture to the stopping position of the registration device. It is customary to provide a framing movement of 0.025 inch above and below this nominal position. For any given projector, use the value of K corresponding to the location of the registration device.

If the film does not stop exactly where the film registration device leaves it, because of coasting or some other cause, a slight adjustment of the value of K will be necessary.

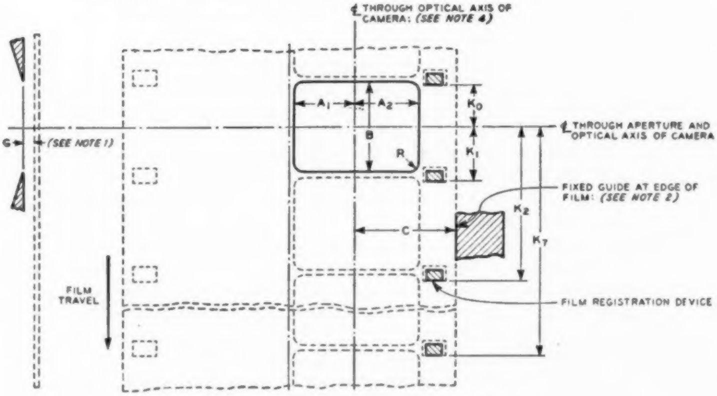
Note 5: "Optical axis of projector" is defined as the mechanical axis or centerline of the sleeve for holding the projection lens. Except for manufacturing tolerances it coincides with the lens axis.

American Standard

Location and Size of Picture Aperture of 8-Millimeter Motion Picture Cameras

ASA
Reg. U. S. Pat. Off.
Z22.19-1950
Revision of
Z22.19-1941
*UDC 778.53

This standard applies to 8-mm. motion picture cameras. It covers the size and shape of the picture aperture and the relative positions of the aperture, the optical axis, the edge guide, and the film registration device. The notes are a part of this standard.



DRAWING SHOWS ARRANGEMENT AS SEEN FROM INSIDE CAMERA LOOKING TOWARD THE LENS

Dimension	Inches	Millimeters	Note
A_1 (measured perpendicular to edge of film)	0.094 min., 0.104 max.	2.39 min., 2.64 max.	1
A_2	0.094 min.	2.39 min.	1
B (measured parallel to edge of film)	$0.138 \begin{smallmatrix} +0.008 \\ -0.001 \end{smallmatrix}$	$3.51 \begin{smallmatrix} +0.20 \\ -0.03 \end{smallmatrix}$	1
C	0.205 ± 0.002	5.21 ± 0.05	2
K_0	0.050 ± 0.002	1.27 ± 0.05	3
K_1	0.100 ± 0.002	2.54 ± 0.05	3
K_2	0.249 ± 0.002	6.32 ± 0.05	3
K_3	0.399 ± 0.002	10.13 ± 0.05	3
K_4	0.549 ± 0.002	13.94 ± 0.05	3
K_5	0.698 ± 0.002	17.73 ± 0.05	3
K_6	0.848 ± 0.002	21.54 ± 0.05	3
K_7	0.998 ± 0.002	25.35 ± 0.05	3
R	0.010 maximum	0.25 maximum	1

Approved March 14, 1950 by the American Standards Association Incorporated
Sponsor: Society of Motion Picture and Television Engineers Incorporated

*Universal Decimal Classification

American Standard **Location and Size of Picture Aperture of 8-Millimeter Motion Picture Cameras**	ASA Reg. U. S. Pat. Off. **Z22.19-1950** Revision of Z22.19-1941 *UDC 778.53

The angle between the vertical edges of the aperture and the edges of normally positioned film shall be 0 degrees, ± ½ degree.

The angles between the horizontal edges of the aperture and the edges of normally positioned film shall be 90 degrees, ± ½ degree.

Note 1: Dimensions A, B, and R apply to the size of the image at the plane of the emulsion; the actual picture aperture has to be slightly smaller. The exact amount of this difference depends on the lens used and on the separation (dimension G) of the emulsion and the physical aperture. G should be no larger than is necessary to preclude scratching of the film. The greatest difference between the image size and aperture size occurs with short focal-length, large diameter lenses.

It is desirable to hold the vertical height of the actual aperture to a value that will insure a real (unexposed) frameline. This results in less distraction when the frameline is projected on the screen than is the case when adjacent frames overlap.

Note 2: The film may be pressed against the fixed edge guide by a spring, by the tendency of the film to tilt in the gate, or by other means. In the second case (generally used in pre-loaded magazines), there is a fixed guide for each edge of the film. The important point is to have the film located in the correct lateral position with respect to the optical axis.

The value of dimension C has been chosen on the assumption that the film will have a slight shrinkage when it is run through the camera. This is the normal condition.

Note 3: The K dimensions are measured along the path of the film from the horizontal centerline of the aperture to the effective stopping position of the registration device. Both the dimensions and tolerances were computed to keep the frameline within 0.002 to 0.005 inch of the centered position for films having shrinkages between 0.0 and 0.5 per cent at the time they are exposed in the camera. For any given camera, use the value of K corresponding to the location of the registering device.

If the film does not stop exactly where the film registration device leaves it, because of coasting or some other cause, a slight adjustment of the value of K will be necessary. This will be indicated if film that has a shrinkage of 0.2 to 0.3 per cent when it is run in the camera does not show a properly centered frameline. From such a test, the amount and direction of the adjustment can be determined.

Note 4: "Optical axis of camera" is defined as the mechanical axis or centerline of the sleeve or other device for holding the picture-taking lens. Except for manufacturing tolerances, it coincides with the optical axis of the lens.

American Standard

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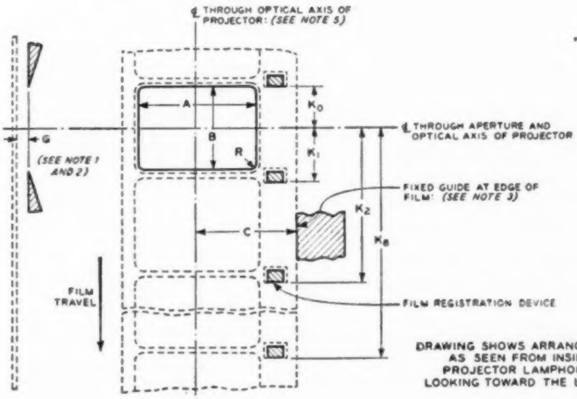

DRAWING SHOWS ARRANGEMENT AS SEEN FROM INSIDE PROJECTOR LAMPHOUSE LOOKING TOWARD THE LENS

Dimension	Inches	Millimeters	Note
A (measured perpendicular to edge of film)	0.172 ± 0.001	4.37 ± 0.03	
B (measured parallel to edge of film)	0.129 ± 0.001	3.28 ± 0.03	1
C	0.205 ± 0.002	5.21 ± 0.05	3
K_0	0.050 ± 0.005	1.27 ± 0.13	4
K_1	0.100 ± 0.005	2.54 ± 0.13	4
K_2	0.249 ± 0.005	6.32 ± 0.13	4
K_3	0.398 ± 0.005	10.11 ± 0.13	4
K_4	0.547 ± 0.005	13.89 ± 0.13	4
K_5	0.696 ± 0.005	17.68 ± 0.13	4
K_6	0.846 ± 0.005	21.49 ± 0.13	4
K_7	0.995 ± 0.005	25.27 ± 0.13	4
K_8	1.144 ± 0.005	29.06 ± 0.13	4
R	0.010 maximum	0.25 maximum	1

Approved March 14, 1950 by the American Standards Association Incorporated
Sponsor: Society of Motion Picture and Television Engineers Incorporated

*Universal Decimal Classification

American Standard

Location and Size of Picture Aperture of 8-Millimeter Motion Picture Projectors

ASA
Reg. U. S. Pat. Off.
Z22.20-1950
Revision of
Z22.20-1941
*UDC 778.55

The angle between the vertical edges of the aperture and the edges of normally positioned film shall be 0 degrees, ± ½ degree.

The angle between the horizontal edges of the aperture and the edges of normally positioned film shall be 90 degrees, ± ½ degree.

Note 1: Dimensions A, B, and R apply to the portion of the image on the film that is to be projected; the actual opening in the aperture plate has to be slightly smaller. The exact amount of this difference depends on the lens used and on the separation (dimension G) of the emulsion and the physical aperture. To minimize the difference in size and make the image of the aperture as sharp as practicable on the screen, G should be no larger than is necessary to preclude scratching of the film. When the reduction in size from the image to the actual aperture is being computed, it is suggested a 1-inch f/1.6 lens be assumed unless there is reason for doing otherwise.

Note 2: The limiting aperture is shown as being between the film and the light source so that it will give the maximum protection from heat. If other factors are more important, it may be on the other side of the film

Note 3: In 8-mm. projectors the edge guide should bear on the edge of the film adjacent to the perforations. The other edge of the film usually is slit after processing and so is more likely to weave laterally with respect to the pictures.

The value of dimension C has been chosen so that film having a slight shrinkage when it is projected will be properly centered. This is the normal condition.

Note 4: The K dimensions are measured along the path of the film from the horizontal centerline of the aperture to the stopping position of the registration device. It is customary to provide a framing movement of approximately 0.025 inch above and below this nominal position. For any given projector, use the value of K corresponding to the location of the registration device.

If the film does not stop exactly where the film registration device leaves it, because of coasting or some other cause, a slight adjustment of the value of K will be necessary.

Note 5: "Optical axis of projector" is defined as the mechanical axis or centerline of the sleeve for holding the projection lens. Except for manufacturing tolerances, it coincides with the lens axis.

American Standard Dimensions for

Mounting Frames for Theater Projection Screens

ASA
Reg. U. S. Pat. Off
Z22.78-1950
*UDC 778.55

1. Scope and Purpose

1.1 This standard specifies dimensions for the mounting frames used for supporting motion picture theater projection screens.

2. Frame Size

2.1 Sizes of frames shall be in accordance with the table below.

2.2 The frame size shall be measured from the inner edge of one side to the inner edge of the opposite side.

2.3 Frames for use with screens of less than 12 feet x 16 feet require 3½ in. minimum clearance on each of the four sides with the minimum clearance increasing as indicated for the larger sizes.

3. Hooks

3.1 Suitable lacing hooks shall be provided on the inner edges of the frames. These hooks shall be spaced on 6 1/32 in. centers starting at points 3 in. on either side of the center of the four sides of the frame.

Table of Frame Sizes

For Screen Size No.	Minimum Inside Dimensions of Frame				Over-All Screen Size Width	Height		For Screen Size No.	Minimum Inside Dimensions of Frame				Over-All Screen Size Width	Height	
	Ft	In.	Ft	In.	Ft	Ft	In.		Ft	In.	Ft	In.	Ft	Ft	In.
8	8	7 ×	6	7	8 ×	6		20	20	10 ×	15	10	20 ×	15	
9	9	7 ×	7	4	9 ×	6	9	21	21	0 ×	16	7	21 ×	15	9
10	10	7 ×	8	1	10 ×	7	6	22	23	1 ×	17	7	22 ×	16	6
11	11	7 ×	8	10	11 ×	8	3	23	24	1 ×	18	4	23 ×	17	3
12	12	7 ×	9	7	12 ×	9		24	25	1 ×	19	1	24 ×	18	
13	13	7 ×	10	4	13 ×	9	9	25	26	1 ×	19	10	25 ×	18	9
14	14	7 ×	11	1	14 ×	10	6	26	27	1 ×	20	7	26 ×	19	6
15	15	7 ×	11	10	15 ×	11	3	27	28	1 ×	21	4	27 ×	20	3
16	16	10 ×	12	10	16 ×	12		28	29	1 ×	22	1	28 ×	21	
17	17	10 ×	13	7	17 ×	12	9	29	30	1 ×	22	10	29 ×	21	9
18	18	10 ×	14	4	18 ×	13	6	30	31	1 ×	23	7	30 ×	22	6
19	19	10 ×	15	1	19 ×	14	3								

Approved March 14, 1950, by the American Standards Association, Incorporated

Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

American Standard Dimensions for

Mounting Frames for Theater Projection Screens

ASA
Reg. U. S. Pat. Off.
Z22.78-1950

Appendix

Projection screens for motion picture theaters are supplied in a variety of materials each of which has its own physical properties. One of these properties is the amount a screen of a given size will stretch after it is laced into a frame. For this reason it may be desired to provide mounting frames with more clearance than that specified in the table. The inside frame dimensions are specified as the minimum dimensions which will give a satisfactory installation when used with an average screen of the corresponding size.

Although frames suitable for mounting theater projection screens may be fabricated from any material of the required strength and rigidity, the following wood structural members are suggested:

For Screen Sizes from No. 8 to 11: 2 x 4 main members with 1 x 3 angle braces at the corners

For Screen Sizes from No. 12 to 19: 2 x 6 main members with 2 x 3 corner braces

For Screen Sizes from No. 20 to 30: 2 x 6 main members with 2 x 3 corner braces and two 2 x 4 vertical center braces spaced approximately 12 feet apart with the addition of a 2 x 6 approximately 12 feet long, reinforcing the spliced main members at top and bottom.

Note: For reference purposes the screen dimensions are also shown in the table. Complete information on screen sizes is given in American Standard Dimensions for Theater Projection Screens, Z22.29-1948.

American Standard for

16-Millimeter Sound Projector Test Film

ASA
Reg. U. S. Pat. Off.
Z22.79-1950
*UDC 778.55

1. Scope and Purpose

1.1 This standard describes a film for qualitatively checking and adjusting 16-mm motion picture sound projection equipment and for judging the acoustical properties of the room in which the sound is reproduced.

2. Test Film

2.1 The film shall have a sound track and accompanying picture. The sound track shall comply with American Standard Sound Records and Scanning Area of 16-Mm Sound Motion Picture Prints, Z22.41-1946, and the film stock used shall be cut and perforated in accordance with American Standard Cutting and Perforating Dimensions for 16-Mm Sound Motion Picture Negative and Positive Raw Stock, Z22.12-1947, or any subsequent revisions thereof.

2.2 The test film shall contain samples selected from studio feature pictures in accordance with the American Standard for Theater Sound Test Film for 35-Mm Motion Picture Sound Reproducing Systems, Z22.60-1948, or any subsequent revisions thereof.

2.3 The assembled film shall contain picture reduced from the 35-mm sound test film, the dimensions of which shall comply with American Standard Location and Size of Picture Aperture of 16-Mm Sound Motion Picture Cameras, Z22.7-1941, or any subsequent revisions thereof.

2.4 The 16-mm release sound track shall be rerecorded from 35-mm original or release tracks through a rerecording channel, the electrical characteristics of which shall comply with current practices* in the industry in rerecording 35-mm feature releases for 16-mm release.

2.5 Each film shall be provided with suitable head and tail leaders. The main title shall include the issue number of the film so that revised versions which may be issued periodically to conform to changing studio practices or to changes in the reproducing characteristic of the 16-mm sound projectors may be easily identified.

2.6 Each film shall be accompanied by an instruction sheet indicating the procedure to be used in checking and adjusting 16-mm projection equipment.

2.7 The length of the film shall be approximately 200 feet.

3. Method of Use

3.1 From a typical location in the room where the sound is reproduced, the observer should determine whether or not the frequency response characteristics of the complete reproducing system are normal by listening to the sound reproduced from the test film when the tone control is set normal and the volume control is set to reproduce the dialogue at normal sound level.

3.2 If the picture and sound quality are displeasing and the dialogue unintelligible, then either:

(*a*) The equipment should be adjusted as shown in the technical manual provided by the manufacturer, or

(*b*) The room in which the sound is reproduced is not suitable.

Methods by which these factors may be determined should be included in the instruction sheet.

NOTE: A test film in accordance with this standard is available from the Motion Picture Research Council or the Society of Motion Picture and Television Engineers.

*See Motion Picture Research Council Practice for Rerecording 16-Mm Release from 35-Mm Release Sound Track N-1.1.

Approved March 14, 1950, by the American Standards Association, Incorporated

Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

Society Announcements

Frank E. Carlson of the General Electric Lamp Division in Nela Park, Cleveland, and **Malcolm G. Townsley,** Vice President in Charge of Engineering of the Bell & Howell Co., Chicago, have been appointed Society Governors for the current year. On March 23rd, E. I. Sponable, President, announced that these two appointments had been made by unanimous consent of the Board of Governors. The vacant terms were created by the amended Constitution that became effective at the beginning of 1950.

William F. Little, long a member of our Society, and Engineer in Charge of the Photometric Dept. of Electrical Testing Laboratories, Inc., New York, has been selected to receive the 1950 Gold Medal of the Illuminating Engineering Society. The medal, to be presented formally during the I.E.S. National Technical Conference at Pasadena, Calif., August 21–25, is being awarded "for meritorious achievement conspicuously furthering the profession, art or knowledge of illuminating engineering."

Mr. Little's work in the field is well known to motion picture engineers who have studied seriously the questions of projection lighting, screen brightness and screen reflectivity characteristics. Many have looked to him for counsel and advice or otherwise drawn heavily on his fund of knowledge or experience, and all will extend their congratulations.

The Society's Constitution and Bylaws are omitted from this year's April JOURNAL, contrary to recent practice, because the Bylaws are in process of amendment and are to be voted on at the 67th Convention in Chicago. The Proposed Bylaw Amendment was introduced and published in full in the March JOURNAL, pp. 367–374. Both Constitution and Bylaws will appear in the May issue.

Members acquainted with the military photographic services will be interested to learn that Col. William W. Jervey, who has been in charge of the U.S. Army Signal Corps photographic activities since September, 1945, has left the Pentagon for Germany. His place as Chief, Army Pictorial Service Div., Office of the Chief Signal Officer, has been taken by Col. Charles S. Stodter, former Commanding Officer of the Signal Corps Photographic Center, Long Island City, N.Y. Lt. Col. Wallace W. Lindsay has assumed command of the Signal Corps Photographic Center.

The Armed Forces Communications Association holds its annual convention at the Commodore Hotel, New York, on Friday, May 12. On Saturday, May 13, the Army Signal Corps and AFCA will present an extensive open house tour of the Signal Corps Engineering Laboratories, the Armed Services Electro-Standards agency and the Signal School, all at Fort Monmouth, N.J. Exhibits will feature important highlights of the work being done by the Communications Services in extensive co-ordination with the manufacturers who supply equipment and industrial research and development laboratories that furnish technical services. If weather permits there will be parachute drops by the 82nd Airborne Division,

demonstrations of wire laying by helicopter and bazooka. Inquiries about this elaborate program should be directed to Col. George P. Dixon, Executive Secretary, AFCA, 1624 Eye St., Connecticut Ave., N.W., Washington 6, D.C.

Student Members

Applications for Student memberships have been coming in at a gradually increasing rate during recent months. This is encouraging to the officers of our two Student Chapters and shows a growing interest on the part of college students in a number of motion picture film courses currently being offered.

In the past, Student memberships have been recorded on a calendar year basis, along with the other grades of memberships; but beginning in March, 1950, all new Student memberships will date from September 1st and continue on a school-year basis. Appropriate arrangements will be made this year so that each member in the Student grade will receive full credit for dues paid and on September 1st they will all be billed for the period from January through August, 1951. All expirations will then occur at the beginning of each new school year.

Engineering Committees

Television

Television broadcasters have had their share of troubles over the past two or three years in adapting motion pictures as a source of television program material. The initial mechanical problems of converting 24-frames/sec motion pictures to 30-frames/sec images for the iconoscope or image orthicon pickup cameras have been generally solved, at least to the extent that results are commercially acceptable. The future is encouraging since several research projects are now moving rapidly toward much improved reproduction of the picture, but acres of virgin territory remain. Characteristics of the ideal television film, mechanical improvements in projection equipment, special television film leaders, cue marks and aperture sizes are a few of the unsolved problems.

In a combined effort to ease the industry's burden, the Society, the Institute of Radio Engineers, and the Radio Manufacturers Association have under discussion a program for the co-ordination of television projects. The major aim is to eliminate duplication of effort that results when engineers are asked to serve on committees of more than one organization working on the same subject or closely related ones. Overlapping committee rosters could be replaced by interlocking memberships so that a minimum of "co-ordination" effort would keep all concerned posted on current progress.

Preliminary plans were considered at a meeting held in New York on March 22nd. The Society was represented by F. T. Bowditch, Engineering Vice President, Boyce Nemec, Executive Secretary, and W. H. Deacy, Staff Engineer; the IRE by Axel Jensen and IRE-RMA co-ordination by M. W. Baldwin. It was agreed that the formation of a correlating body would be recommended on which the IRE, RMA and SMPTE would be represented. This group would allocate new projects as they arose to the organization best qualified.

To implement the Society's share in this project, a major reorganization of the Society's Television Committees and reassignment of projects were announced on March 22nd by Mr. Bowditch. Two of the groups that will replace the former Television Committee are the committees on Television Studio Lighting and on

Films for Television. Others will be formed as required. The Society's long standing Theater Television Committee will continue without change on its work with the motion picture producers, exhibitors, the common carriers and the Federal Communications Commission. Memberships and scopes of these committees are shown in the roster of Society committees elsewhere in this JOURNAL.

Current Literature

THE EDITORS present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer
vol. 31, no. 1, January, 1950
Economy Lighting with Photofloods (p. 10) F. FOSTER
Carbon Arc Studio Lighting (p. 11) W. W. LOZIER
The Production of Films for Television (p. 12)
Rating Color Temperature (p. 13) D. NORWOOD
New Multiple Sound Track for 16mm Films (p. 14) L. ALLEN
Lighting for Color Movies (p. 16) C. LORING

British Kinematography
vol. 15, no. 6, December, 1949
Improvements in Large Screen Television Projection (p. 178) T. M. C. LANCE
Discharge Lamps in Relation to Film Projection (p. 191) A. G. PENNY

vol. 16, no. 1, January, 1950
A Small Continuous Processing Machine for Experimental Work (p. 2) G. I. P. LEVENSON
The Film in Relation to Agricultural Engineering (p. 9) D. HARDY
Standardization and the Kinema:
Introduction (p. 17) S. B. HARRISON-SWINGLER
Standards and the Exhibitor (p. 18) L. KNOPP
Standards for Projection Equipment (p. 18) S. A. STEVENS
International Standardization (p. 19) C. H. BELL
Standardization Combats Film Mutilation (p. 20) R. H. CRICKS

Electronic Engineering
vol. 22, no. 1, January, 1950
Recording of Television (p. 8)

Electronics
vol. 23, no. 1, January, 1950
Dot Systems of Color Television (p. 96) W. BOOTHROYD

International Photographer
vol. 21, no. 12, December, 1949
New Type Variable Area 16mm Track, Introduced by J. A. Maurer, Inc. (p. 22)
Bell & Howell Camera Records Life at Greatest Sea Depth (p. 22)

vol. 22, No. 2, February, 1950
Three Dimensional Photography (p. 12) A. WYCKOFF
Motion Picture Films in TV (p. 18)

International Projectionist
vol. 25, no. 1, January, 1950
The 35-mm Projection Positive Film, Pt. III, (p. 5) R. A. MITCHELL
Theatre Television: What, How and When (p. 13) J. E. McCOY and H. P. WARNER

vol. 25, no. 2, February, 1950
The 35-mm Projection Positive Film, Pt. IV, (p. 7) R. A. MITCHELL
The New Simplex X-L 35-mm Projector Mechanism (p. 14)

Kinematograph Weekly
vol. 394, no. 2224, December 15, 1949
Colour Developments Reviewed (p. 63) J. H. COOTE
Independent Frame Process Puts Film Making on Factory Basis (p. 67) R. H. CRICKS
How to Choose a Projector (p. 144) J. COOPER

Book Review

Noise and Sound Transmission, Report of the 1948 Summer Symposium of the Acoustics Group

Published (1949) by The Physical Society, 1 Lowther Gardens, Prince Consort Road, London S. W. 7. 200 pp. 130 figs. 20 tables. Paper bound, 7 × 10 in. (This publication is available from the Acoustical Society of America, 57 E. 55th St., New York 22, for $2.75 including postage and handling charges. Remittances should be sent with the orders and should be made out to the Acoustical Society of America.)

We are indebted to the Acoustics Group of The Physical Society (London) for the publication in this book of 41 papers on sound transmission and noise presented by a gathering of experts from twelve countries. Although the principal emphasis in most of the papers is on the insulation of sound in homes and apartments, there are also reported in the volume fruitful studies of the nature of air-borne and impact sounds, recommended standard and field methods of measuring the sound insulation of floors, walls, windows and other partitions, and a variety of other related topics.

Some findings reported at the symposium, of interest to motion picture and radio engineers, are the following:

"...double glazing (of windows) is slightly worse acoustically than single glazing of the same total superficial weight... There is no acoustical advantage in fitting glazing heavier than about '24 oz.' unless the opening sections of a window have a very good closure." [G. H. Aston]

"The reduction of the stiffness of thin panels increases their sound insulation." [L. Cremer]

"The loudness levels in phons of some typical complex noises are shown to be 3 to 17 phons greater than the corresponding sound levels in decibels as determined by a sound level meter." [A. J. King]

"In England, the noise from the banging of the neighbors' doors appears to be more troublesome than that from their radios." [W. A. Allen]

A reading of the papers presented at the symposium reveals that at least in the construction of residental flats and apartments, the Europeans are making more progress than we are in the control and insulation of noise. Anyone interested in noise and sound insulation problems will find practical solutions to many of these problems in *Noise and Sound Transmission*.

Vern O. Knudsen
University of California
Los Angeles 24, Calif.

Journals Available

The following 33 back numbers of the Journal, and one Index, are available at the job lot price of $25.00 from Mr. E. W. Noli, Pacent Engineering Corp., 79 Madison Ave., New York 16.

1931, Dec. 1932, Jan.–Dec. 1933, Jan.–Dec. 1934, May–Dec.
Index for 1930–35

New Products

Further information concerning the material described below can be obtained by writing direct to the manufacturers. As in the case of technical papers, publications of these news items does not constitute endorsement of the manufacturer's statements nor of his products.

RCA's new industrial television system consists of two units: an 8-lb TV camera and a master control monitor about the size of a suitcase. The camera is 10 in. long, 3 in. wide and 5 in. high. It has only three tubes, including the newly developed Vidicon pickup tube which is about 1 in. in diameter and 6 in. long. The Vidicon is based on the principle of photoconductivity, rather than employing photoemissive cells as used by the image orthicon and other pickup tubes in general use. Ordinary 16-mm motion picture lenses are used. The camera has a remote focusing mount, which permits the operator to adjust optical focus by remote control from the master control unit.

The system operates on 110-v, 60-cycle alternating current and consumes 350 watts. It is reported capable of transmitting a signal 250 ft over a coaxial cable closed circuit. It has a scanning frequency of 525 lines, 60 frames interlaced, and is compatible with standard television broadcasting techniques.

The master control unit of the system is 24 in. long, 15 in. high, $8\frac{1}{4}$ in. deep and weighs 58 lb. It contains a regulated power supply, small synchronizing signal generator, a video amplifier strip and all the scanning deflection equipment

for both the camera and its own 7-in. monitoring kinescope. It contains 44 tubes.

By providing safe and convenient viewpoints, it is expected that this system will prove an aid to education and industrial efficiency. The RCA Engineering Products Dept., Camden, N.J., has issued a bulletin, ITV-1, which gives an over-all description of possible uses. RCA has noted that installation of the system could prevent such episodes as the robbery of the Brink vaults in Boston, and the first public demonstration was that of monitoring prisoners in the City Prison of Manhattan. For job training in industry and educating in the armed forces, schools and hospitals, the system will present demonstrations, close-up views of experiments or enlargements of microscopic studies. In industry, products may be inspected and processes watched in positions or environments insufferable or inconvenient for immediate human attendance.

Meetings of Other Societies

Institute of Radio Engineers, Cincinnati Section, Spring Technical Conference on Television, April 29, Cincinnati, Ohio

Institute of Radio Engineers, Technical Conference, May 3–5, Dayton, Ohio

Armed Forces Communications Assn., Annual Meeting,
May 12, New York, and Long Island City
May 13, Fort Monmouth, N.J.

Acoustical Society of America, Spring Meeting, June 22–24, State College, Pa.

Illuminating Engineering Society, National Technical Conference, August 21–25, Pasadena, Calif.

Employment Service

POSITIONS WANTED

In Manufacturing: Broad experience in developing, improving and producing of home movie cameras and projectors. Good technical background. Desire position with mfr. Earle F. Orr, 345 Fellsway West, Medford, Mass.

With 35-Mm Production Unit: Young veteran desires to learn motion picture production. Will work in any capacity. Single, 23, with 8 yr theater experience, all phases; mgr small house 3 yr; 2 yr A.M.P.S. projectionist supervisor; grad. AAF Photo School and Motion Picture Inst. production course. Have private library of over 200 film books; serious student of films since 15. Currently employed; detailed letter and refs readily supplied; salary no object. John P. Lowe, 265 State St., Northampton, Mass.

Producer-Director-Editor: 10 yr with major film producers. Thorough knowledge and experience script-to-screen production technique: directing, photography, editing, laboratory problems, sound recording, 35- and 16-mm, b & w. Specialist in research and production of educational and documentary films; small budget commercial and TV films. Long experience in newsreels. Desire greater production possibilities, go anywhere. Member SMPTE, top refs. E. J. Mauthner, P. O. Box 231, Cathedral Sta., New York 25.

POSITIONS WANTED

TV and Motion Picture Engineer: 3 yr experience in motion picture engineering and research at Philips Physical Laboratories, Eindhoven; 6 yr as TV-Director, same firm; 3 yr as Director of Decca plant in Belgium. Desires assignment in any part U.S.A. Highest qualifications and references U.S. firms. Write Fernand Beguin, c/o Mr. Marc Albanese, 416 Madison Ave., New York 17.

In technical phase: Motion picture or still photography. 4 yr experience in research, development, and testing, both color and b & w films. Graduating from M.I.T. June, 1950. Member, SMPTE. W. A. Farmer, 141 Grand Ave., Rochester 9, N.Y.

Cameraman-Director: Currently employed by internationally known producer, desires greater production opportunities. Fully experienced 35- and 16-mm, color, b & w; working knowledge editing, sound, and laboratory problems; administrative experience. Top references and record of experience available. Write P.O. Box 5402, Chicago.

Cameraman: Trained with practical experience in 16-mm and 35-mm equipment & technique with prominently successful men in the industry. Thoroughly familiar with B & H Standard, Mitchell, Eyemo, & Filmo cameras, Moviolas, etc. Thorough knowledge & experience script-to-screen production technique; directing, editing, photography, film evaluation, production, treatments, shooting-scripts, small budgets, documentary & theatrical production. Go anywhere. Age 33. Top industry & character references furnished confidentially. Anxious for position where ability, sincere interest and creativeness offer opportunity. Active Member of SMPTE. Write Milton L. Kruger, R.F.D. 1, Ridgewood, N.J.

SMPTE Officers and Committees: The roster of Society Officers is scheduled for publication in the May JOURNAL. The Committee Chairmen and Members are shown in this issue. Changes in these listings are scheduled for the September JOURNAL.

SMPTE HONOR ROLL

By action of the Board of Governors, October 4, 1931, this Honor Roll was established for the purpose of perpetuating the names of distinguished pioneers who are now deceased.

Louis Aimé Augustin Le Prince
William Friese-Greene
Thomas Alva Edison
George Eastman
Frederic Eugene Ives
Jean Acme Le Roy
C. Francis Jenkins
Eugene Augustin Lauste
William Kennedy Laurie Dickson
Edwin Stanton Porter
Herman A. DeVry
Robert W. Paul
Frank H. Richardson
Leon Gaumont
Theodore W. Case
Edward B. Craft
Samuel L. Warner
Louis Lumiere
Thomas Armat

HONORARY MEMBERS

Lee de Forest **A. S. Howell**

Committees of the Society

As of April 1, 1950

ADMINISTRATIVE COMMITTEES

ADMISSIONS. *To pass upon all applications for membership, applications for transfer, and to review the Student and Associate membership list periodically for possible transfer to the Associate and Active grades, respectively. The duties of each committee are limited to applications and transfers originating in the geographic area covered.*

E. A. Bertram, *Chairman, East,* DeLuxe Laboratories, 850 Tenth Ave., New York 19, N.Y.

R. B. Austrian	Herbert Barnett	H. D. Bradbury	C. R. Keith
		Richard Hodgson	W. H. Rivers

G. E. Sawyer, *Chairman, West,* Samuel Goldwyn Studio Corp., 1041 N. Formosa Ave., Hollywood 46, Calif.

C. R. Daily	George Friedl, Jr.	L. D. Grignon	J. P. Livadary

BOARD OF EDITORS. *To pass upon the suitability of all material submitted for publication, or for presentation at conventions, and publish the* Journal.

A. C. Downes, *Chairman,* 2181 Niagara Dr., Lakewood 7, Ohio

M. R. Boyer	A. W. Cook	C. W. Handley	G. E. Matthews
L. F. Brown	J. G. Frayne	A. C. Hardy	Pierre Mertz
	A. M. Gundelfinger	P. J. Larsen	J. H. Waddell

CONVENTION. *To assist the Convention Vice-President in the responsibilities pertaining to arrangements and details of the Society's technical conventions.*

W. C. Kunzmann, *Chairman,* National Carbon Division, Box 6087, Cleveland 1, Ohio

G. W. Colburn	E. R. Geib	L. B. Isaac	E. S. Seeley
C. R. Daily	H. F. Heidegger	O. F. Neu	N. L. Simmons
			R. T. Van Niman

EUROPEAN ADVISORY COMMITTEES. *To act as liaison between the general Society and European firms, individuals, and organizations interested in motion picture and television engineering. To report to the Society on such affairs in Europe, on new technical developments, and to assist the Papers Committee in soliciting papers for publication in the* Journal.

I. D. Wratten, *Chairman (British Division),* Kodak, Ltd., Kingsway, London, England

R. H. Cricks	W. M. Harcourt	L. Knopp	A. W. Watkins

L. Didiée, *Chairman (Continental Division)* Association Française des Ingénieurs et Techniciens du Cinéma, 92 Champs-Elysées, Paris (8e), France

R. Alla	M. Certes	S. Feldman	M. Terrus
R. Bocquel	J. Cordonnier	J. Fourrage	J. Vivié
		G. Mareschal	M. Yvonnet

FELLOW AWARD. *To consider publications of Active members as candidates for elevation to Fellow, and to submit such nominations to the Board of Governors.*

L. L. Ryder, *Chairman*, Paramount Pictures, 5451 Marathon St., Hollywood 38, Calif.

R. B. Austrian	R. M. Corbin	W. C. Kunzmann	Edward Schmidt
F. T. Bowditch	C. R. Daily	J. A. Maurer	S. P. Solow
F. E. Cahill	D. B. Joy	Peter Mole	E. I. Sponable
G. W. Colburn	C. R. Keith	W. H. Rivers	R. T. Van Niman

HISTORICAL AND MUSEUM. *To collect facts and assemble data relating to the historical development of the motion picture and television industries, to encourage pioneers to place their work on record in the form of papers for publication in the* JOURNAL, *and to place in suitable depositories equipment pertaining to the industry.*

Edward F. Kerns, *Chairman*, Buckingham Apts., Scarsdale, N.Y.

W. H. Offenhauser, Jr., *Vice-Chairman*, River St. & Charles Pl., New Canaan, Conn.

G. J. Badgley	L. W. Bonn	W. A. Jamison	Terry Ramsaye
J. A. Ball	H. T. Cowling	Beaumont Newhall	E. I. Sponable
			Randall Terraneau

HONORARY MEMBERSHIP. *To search diligently for candidates who through their basic inventions or outstanding accomplishments have contributed to the advancement of the motion picture industry and are thus worthy of becoming Honorary members of the Society.*

G. A. Chambers, *Chairman*, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

Herbert Griffin	W. C. Miller	Terry Ramsaye	R. O. Strock

JOURNAL AWARD. *To recommend to the Board of Governors the author or authors of the most outstanding paper originally published in the* JOURNAL *during the preceding calendar year to receive the Society's* JOURNAL *Award.*

C. R. Daily, *Chairman*, Paramount Pictures, 5451 Marathon St., Hollywood 38, Calif.

Otto Sandvik	Fred Schmid	M. G. Townsley	J. E. Volkmann

MEMBERSHIP AND SUBSCRIPTION. *To solicit new members, obtain nonmember subscriptions for the* JOURNAL, *and to arouse general interest in the activities of the Society and its publications.*

L. E. Jones, *General Chairman*, Neumade Products Corp., 330 W. 42 St., New York 18.

A. G. Smith, *Chairman, Atlantic Coast*, National Theatre Supply, 356 W. 44 St., New York 18, N.Y.

Bertil Carlson	T. J. Gaski	W. C. Kunzmann	C. W. Seager
A. R. Gallo	N. D. Golden	O. F. Neu	Harry Sherman
	C. F. Horstman	P. D. Ries	C. R. Wood, Sr.

Arthur H. Bolt, *Chairman, Central*, Bell & Howell Co., 7100 McCormick Road, Chicago.

Steve Hunter	G. L. Oakley	J. L. Wassell	

E. W. Templin, *Chairman, Pacific*, 822 Parkman Dr., La Canada, Calif.

(Under Organization)

Frank Rogers, Jr., *Chairman, 16-Mm*, Ampro Corp., 545 Fifth Ave., New York 17.

G. A. Chambers	Robert Craig	W. F. Kruse	Edward H. Stevens
Bernard A. Cousino	Henry M. Fisher	Lawrence Saltzman	Stuart S. Tait
			Lloyd Thompson

H. S. Walker, *Chairman, Foreign*, 1620 Notre Dame St., W., Montreal, Que., Canada

A. F. Baldwin	Walter Bird	R. J. Engler	H. R. Holm
	Vernon T. Dickins	Y. A. Fazalbhoy	R. O. Strock

NOMINATIONS. *To recommend nominations to the Board of Governors for annual election of officers and governors.*

D. E. Hyndman, *Chairman,* Eastman Kodak Co., 342 Madison Ave., New York 17, N.Y.

F. T. Bowditch	R. L. Garman	A. N. Goldsmith	Paul Larsen
R. E. Farnham	George Giroux	T. T. Goldsmith	E. S. Seeley

PAPERS. *To solicit papers and provide the program for semiannual conventions, and make available to local sections for their meetings papers presented at national conventions.*

N. L. Simmons, *Chairman,* Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38, Calif.
Joseph E. Aiken, *Vice-Chairman,* 116 N. Galveston St., Arlington, Va.
L. D. Grignon, *Vice-Chairman,* 20th Century-Fox Films Corp., Beverly Hills, Calif.
E. S. Seeley, *Vice-Chairman,* Altec Service Corp., 161 Sixth Ave., New York 13, N.Y.
R. T. Van Niman, *Vice-Chairman,* 4501 Washington Blvd., Chicago 24, Ill.
H. S. Walker, *Vice-Chairman,* 1620 Notre Dame St., W., Montreal, Que., Canada

F. G. Albin	W. P. Dutton	Pierre Mertz	Edward Schmidt
John Arnold	J. L. Forrest	W. J. Morlock	V. C. Shaner
G. A. Burns	L. R. Martin	O. W. Murray	W. L. Tesch
Phillip Caldwell	G. E. Matthews	W. H. Rivers	J. W. Thatcher

PROGRESS. *To prepare an annual report on progress in the motion picture and television industries.*

C. W. Handley, *Chairman,* 1960 West 84 St., Los Angeles, Calif.

J. E. Aiken	G. H. Gordon	W. A. Mueller	J. W. Thatcher
L. W. Browder	R. E. Lewis	W. L. Tesch	W. V. Wolfe

PROGRESS MEDAL AWARD. *To recommend to the Board of Governors a candidate who by his inventions, research, or development has contributed in a significant manner to the advancement of motion picture technology, and is deemed worthy of receiving the Progress Medal Award of the Society.*

J. G. Frayne, *Chairman,* Electrical Research Products, 6601 Romaine St., Los Angeles 38, Calif.

R. M. Corbin	R. L. Garman	Barton Kreuzer	T. T. Moulton

PUBLICITY. *To assist the Convention Vice-President in the release of publicity material concerning the Society's semiannual technical conventions.*

Harold Desfor, *Chairman,* RCA Victor Division, Camden, N.J.

Leonard Bidwell	George Daniel	Harry Sherman	R. T. Van Niman
		N. L. Simmons	Harold Wengler

PUBLIC RELATIONS. *To assist the President at all times in improving the Society's public relations.*

Irving Kahn, *Chairman,* Twentieth Century-Fox, 444 West 56 St., New York 19, N.Y.

Ralph Austrian	Harold Desfor	Peter Mole	R. T. Van Niman

SUSTAINING MEMBERSHIP. *To solicit new sustaining members and thereby obtain adequate financial support required by the Society to carry on its technical and engineering activities.*

D. E. Hyndman, *Acting Chairman,* Eastman Kodak Co., 342 Madison Ave., New York 17, N.Y.

L. L. Ryder	R. T. Van Niman

SAMUEL L. WARNER AWARD. *To recommend to the Board of Governors a candidate who has done the most outstanding work in the field of sound motion picture engineering, in the development of new and improved methods or apparatus designed for sound motion pictures, including any steps in the process, and who, whether or not a Member of the Society of Motion Picture Engineers, is deemed eligible to receive the Samuel L. Warner Memorial Award of the Society.*

W. V. Wolfe, *Chairman*, Motion Picture Research Council, 1421 N. Western Ave., Hollywood 27, Calif.

E. M. Honan	J. P. Livadary	W. W. Lozier	E. A. Williford

ENGINEERING COMMITTEES

CINEMATOGRAPHY. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture cameras, accessory equipment, studio and outdoor-set lighting arrangements, camera technique and the varied uses of motion picture negative films for general photography.*

C. G. Clarke, *Chairman*, 20th Century-Fox Film Corp., Beverly Hills, Calif.

J. W. Boyle	Karl Freund	A. J. Miller	Arthur Reeves
			Joseph Ruttenberg

COLOR. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of color motion picture processes, accessory equipment, studio lighting, selection of studio set colors, color cameras, color motion picture films, and general color photography.*

H. H. Duerr, *Chairman*, Ansco, Binghamton, N.Y.

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O. O. Ceccarini	R. M. Evans	W. W. Lozier	L. E. Varden

FILM DIMENSIONS. *To make recommendations and prepare specifications on those film dimensions which affect performance and interchangeability, and to investigate new methods of cutting and perforating motion picture film in addition to the study of its physical properties.*

E. K. Carver, *Chairman*, Eastman Kodak Co., Kodak Park, Rochester 4, N.Y.

E. A. Bertram	A. M. Gundelfinger	W. E. Pohl	William Wade
A. F. Edouart	W. G. Hill	N. L. Simmons	Fred Waller
	A. J. Miller	M. G. Townsley	Deane R. White

FILM-PROJECTION PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture projection equipment, projection rooms, film-storage facilities, stage arrangement, screen dimensions and placement, and maintenance of loudspeakers to improve the quality of reproduced sound and the quality of the projected picture in the theater.*

L. W. Davee, *Chairman*, Century Projector Corp., 729 Seventh Ave., New York 19, N.Y.

C. S. Ashcraft	Frank Cahill	C. F. Horstman	Paul Ries
	R. H. Heacock	G. T. Lorance	Harry Rubin

FLICKER (TEMPORARY). *To locate, obtain, peruse, and summarize the available literature on the subject of picture flicker resulting from any part of the motion picture process, with particular emphasis on those components of such flicker as are superimposed upon the basic frame or shutter rates. On the basis of the committee findings to recommend to the Society such further action as is deemed necessary or desirable.*

L. D. Grignon, *Chaiman*, 20th Century-Fox Film Corp., Box 900, Beverly Hills, Calif.

F. B. Berger
A. A. Eastman
T. L. Jahn
E. F. Kingsbury
E. C. Manderfelt

FILMS FOR TELEVISION. *To make recommendations and prepare specifications on all phases of the production, processing and use of film made for transmission over a television system excluding video transcriptions.*

R. L. Garman, *Chairman*, General Precision Laboratories, Inc., 68 Bedford Road, Pleasantville 1, N.Y.

(Under Organization)

HIGH-SPEED PHOTOGRAPHY. *To make recommendations and prepare specifications for the construction, installation, operation, and servicing of equipment for photographing and projecting pictures taken at high repetition rates or with extremely short exposure times.*

J. H. Waddell, *Chairman*, Bell Telephone Laboratories, Inc., Whippany, N.J.

H. E. Edgerton, *Vice-Chairman*, Dept of Electrical Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.

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D. M. Beard
H. W. Crouch
C. H. Elmer
R. E. Farnham
W. R. Fraser
W. H. Fritz
Eleanor Gerlach
C. C. Herring
H. M. Lester
L. R. Martin
C. D. Miller
Arthur Neyhart
W. S. Nivison
Brian O'Brien
D. H. Peterson
Earl Quinn
M. L. Sandell
Kenneth Shaftan
C. W. Wyckoff
A. M. Zarem

LABORATORY PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture printers, processing machines, inspection projectors, splicing machines, film-cleaning and treating equipment, rewinding equipment, any type of film-handling accessories, methods, and processes which offer increased efficiency and improvements in the photographic quality of the final print.*

J. G. Stott, *Chairman*, Du-Art Film Laboratories, 245 West 55 St., New York, N.Y.

V. D. Armstrong
H. L. Baumach
David Boyle
G. E. Cantor
I. M. Ewig
Thomas Ingman
Paul Kaufman
C. F. LoBalbo
O. W. Murray
W. E. Pohl
Edward Reichard
V. G. Shaner
Joseph Spray
Lloyd Thompson
Paul Zeff

MOTION PICTURE STUDIO LIGHTING. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of all types of studio and outdoor auxiliary lighting equipment, tungsten light and carbon-arc sources, lighting-effect devices, diffusers, special light screens, etc., to increase the general engineering knowledge of the art.*

M. A. Hankins, *Chairman*, Mole-Richardson Co., 937 N. Sycamore Ave., Hollywood 38, Calif.

Richard Blount
J. W. Boyle
Karl Freund
C. W. Handley
C. R. Long
W. W. Lozier
D. W. Prideaux
Petro Vlahos

OPTICS. *To make recommendations and prepare specifications on all subjects connected with lenses and their properties.*

R. Kingslake, *Chairman*, Eastman Kodak Co., Hawk Eye Works, Rochester 4, N.Y.

F. G. Back	C. R. Daily	Grover Laube	A. E. Murray
L. E. Clark	I. C. Gardner	J. A. Maurer	L. T. Sachtleben
Allen Cook	J. W. Gillon	G. A. Mitchell	O. H. Schade
			M. G. Townsley

PRESERVATION OF FILM. *To make recommendations and prepare specifications on methods of treating and storage of motion picture film for active, archival, and permanent record purposes, so far as can be prepared within both the economic and historical value of the films.*

J. W. Cummings, *Chairman*, National Archives, Washington 25, D.C.

Henry Anderson	L. E. Clark	J. E. Gibson	J. B. McCullough
W. G. Brennan	J. W. Dunham	G. G. Graham	N. F. Oakley
	C. R. Fordyce	A. C. Hutton	W. D. Stump

PROCESS PHOTOGRAPHY. *To make recommendations and prepare specifications on motion picture optical printers, process projectors (background process), matte processes, special process lighting technique, special processing machines, miniature-set requirements, special-effects devices, and the like, that will lead to improvement in this phase of the production art.*

(Under Organization)

Merle H. Chamberlin, *Chairman*, Metro-Goldwyn-Mayer Studios, Culver City, Calif.

SCREEN BRIGHTNESS. *To make recommendations, prepare specifications, and test methods for determining and standardizing the brightness of the motion picture screen image at various parts of the screen, and for special means or devices in the projection room adapted to the control or improvement of screen brightness.*

W. W. Lozier, *Chairman*, National Carbon Div., Fostoria, Ohio

Herbert Barnett	L. T. Goldsmith	F. J. Kolb	Allen Stimson
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E. R. Geib	L. B. Isaac	B. A. Silard	A. T. Williams
			D. L. Williams

16-MM AND 8-MM MOTION PICTURES. *To make recommendations and prepare specifications for 16-mm and 8-mm cameras, 16-mm sound recorders and sound-recording practices, 16-mm and 8-mm printers and other film laboratory equipment and practices, 16-mm and 8-mm projectors, splicing machines, screen dimensions and placement, loudspeaker output and placement, preview or theater arrangements, test films, and the like, which will improve the quality of 16-mm and 8-mm motion pictures.*

H. J. Hood, *Chairman*, Eastman Kodak Company, 343 State Street, Rochester 4, N.Y.

H. W. Bauman	E. W. D'Arcy	W. W. Lozier	A. G. Petrasek
W. C. Bowen	J. W. Evans	D. F. Lyman	A. C. Robertson
F. L. Brethauer	C. R. Fordyce	W. C. Miller	L. T. Sachtleben
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S. L. Chertok	Rudolf Kingslake	W. H. Offenhauser, Jr.	Lloyd Thompson
			M. G. Townsley

SOUND. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture film, sound recorders, re-recorders, and reproducing equipment, methods of recording sound, sound-film processing, and the like, to obtain means of standardizing procedures that will result in the production of better uniform quality sound in the theater.*

L. T. Goldsmith, *Chairman*, Warner Brothers Pictures, Inc., Burbank, Calif.

G. L. Dimmick, *Vice-Chairman*, RCA Victor Division, Camden, N.J.

F. G. Albin	R. J. Engler	L. B. Isaac	G. E. Sawyer
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D. J. Bloomberg	J. G. Frayne	K. M. MacIlvain	W. L. Thayer
F. E. Cahill, Jr.	L. D. Grignon	W. C. Miller	M. G. Townsley
E. W. D'Arcy	Robert Herr	G. C. Misener	R. T. Van Niman
	J. K. Hilliard	Otto Sandvik	D. R. White

STANDARDS. *To survey constantly all engineering phases of motion picture production, distribution, and exhibition, to make recommendations and prepare specifications that may become proposals for American Standards. This Committee should follow carefully the work of all other committees on engineering and may request any committee to investigate and prepare a report on the phase of motion picture engineering to which it is assigned.*

F. E. Carlson, *Chairman*, General Electric Company, Nela Park, Cleveland 12, Ohio

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TELEVISION STUDIO LIGHTING. *To make recommendations and prepare specifications on all phases of lighting employed in television studios.*

Richard Blount, *Chairman*, General Electric Co., Nela Park, Cleveland 12, Ohio

A. H. Brolly	H. M. Gurin	Eric Herud	R. S. O'Brien
		Robert Morris	R. L. Zahour

THEATER ENGINEERING. *To make recommendations and prepare specifications of engineering methods and equipment of motion picture theaters in relation to their contribution to the physical comfort and safety of patrons, so far as can be enhanced by correct theater design, construction, and operation of equipment.*

Leonard Satz, *Chairman*, Century Theaters, 132 W. 43 St., New York 18, N.Y.

F. W. Alexa	Charles Bachman	James Frank, Jr.	Ben Schlanger
Henry Anderson	E. J. Content	Aaron Nadell	Seymour Seider
O. P. Beckwith	C. M. Cutler	E. H. Perkins	Emil Wandelmaier

THEATER TELEVISION. *To make recommendations and prepare specifications for the construction, installation, operation, maintenance, and servicing of equipment for projecting television pictures in the motion picture theater, as well as projection-room arrangements necessary for such equipment, and such picture-dimensional and screen-characteristic matters as may be involved in high-quality theater-television presentations.*

D. E. Hyndman, *Chairman*, Eastman Kodak Co., 342 Madison Ave., New York 17, N.Y.

Ralph Austrian	A. N. Goldsmith	L. B. Isaac	Harry Rubin
G. L. Beers	T. T. Goldsmith, Jr.	A. G. Jensen	L. L. Ryder
F. E. Cahill, Jr.	Nate Halpern	P. J. Larsen	Otto Sandvik
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E. P. Genock		G. P. Mann	E. I. Sponable
		F. R. Norton	J. E. Volkmann

VIDEO RECORDING. *To make recommendations and prepare specifications on all phases of motion picture film recording of picture and sound being transmitted over a television system.*

(Under Organization)

SMPTE REPRESENTATIVES TO OTHER ORGANIZATIONS

AMERICAN STANDARDS ASSOCIATION

Standards Council, D. E. Hyndman

SECTIONAL COMMITTEES

Standardization of Letter Symbols and Abbreviations for Science and Engineering, Z10, S. L. Chertok

Motion Pictures, Z22

J. A. Maurer, *Chairman*, J. A. Maurer, Inc., 37-01 31 St., Long Island City 1, N.Y.
W. H. Deacy, *Secretary*

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INTER-SOCIETY COLOR COUNCIL

R. M. Evans, *Chairman*, Eastman Kodak Co., 59 Kodak Park, Rochester 4, N.Y.

J. A. Ball	M. R. Boyer	L. E. Clark	H. C. Harsh
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UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON ILLUMINATION

R. E. Farnham, *Chairman*, General Electric Co., Nela Park, Cleveland 12, Ohio

Herbert Barnett H. E. White

AMERICAN DOCUMENTATION INSTITUTE

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Test Films

The sound test films were developed initially by the Society and the Research Council for use in motion pictures but many now find application in television as well. Recently two television test films have been added.

For Manufacturers **In design they are the yardsticks for setting performance objectives of new equipment. In production they are standard tools of inspection.**

For Television **As a uniform source of film signal for lining up the film pickup system, they aid in proper mechanical adjustment of the projector and its sound reproducer mechanism.**

For "In Service" Maintenance **There are films that tell what is wrong when the projector is not operating correctly. Others are for use after repairs, while adjustments are being made. They indicate when performance is again within specifications.**

For Film Users **There is a film that takes the guesswork out of projector performance. It clearly shows whether poor performance is the fault of the projector or the film, and indicates when projector overhaul is necessary.**

For Equipment Dealers **There are test films with picture and sound of typical release print quality that make individual or comparative demonstration of projectors meaningful.**

Write the Society for the 16-Mm and 35-Mm Test Films catalog, if you do not have one.

Sustaining Members

OF THE

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